DEN NORSKE NORDHAVS-EXPEDITION

1876—1878.

1. BIND.

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FÖRSTE BIND.

THE NORWEGIAN NORTH-ATLANTIC EXPEDITION

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First Volume.

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HISTORISK BERETNING

AF

C. WILLE,

KAPTEJN I MARINEN.

MED ET KART.

CHRISTIANIA.

GRØNDAHL & SØNS BOGTRYKKERI.

1882.

THE NORWEGIAN NORTH-ATLANTIC EXPEDITION

1876—1878.

HISTORICAL ACCOUNT.

BY

C. WILLE,

CAPTAIN OF THE ROYAL NAVY.

WITH A MAP.

CHRISTIANIA.

PRINTED BY GRØNDAHL & SØN.

1882.

Under 19de Marts 1874 indsendte Professorerne H. Mohn og G. O. Sars til den kongelige norske Regjerings Departement for det Indre en Forestilling saalydende:

Gjennem vore Studier af vort Lands Naturforhold ere vi komne til den Overbevisning, at Forklaringen og Forstaaelsen af disse maa søges hovedsagelig i Forholdene i det Hav, som omsluttes af Norge, Færoerne, Island, Jan Mayen og Spidsbergen. Denne Del af Verdenshavet danner et stort Bassin, i hvilke Atlanterhavets varme Vande støde sammen med Ishavets kolde. De Bidrag til Kundskaben om dette Hav, som hidtil foreligge, gjælde hovedsagelig alene Bækkenets Rand, og skyldes for den største Del Forskninger, anstillede af Expeditioner, udsendte fra fremmede Lande. Saaledes have de forskjellige Svenske og Franske Expeditioner til Spidsbergen givet udmerkede Oplysninger om Bassinets østlige Rand, og de fra England med Dampskibene "Lightning" og "Porcupine" i 1869 og 1870 udsendte Expeditioner have tilvejebragt Oplysninger om dets sydvestlige Rand mellem Skotland og Færøerne, der i mere end en Henseende maa kaldes epokegjørende. Hvor Havet støder op til Norges Kyst ere Forholdene inde ved Kysten blevne undersøgte dels ved vore Zoologers Arbeider, dels i de senere Aar ved de med Oplodningsdampskibet "Hansteen" udførte Expeditioner. Fra det aabne Hav derimod er det yderlig lidet, der er tilveiebragt af Oplysninger. Norske Sælfangere have vistnok siden 1867 jevnlig hver Vaar anstillet meteorologiske Iagttagelser og lejlighedsvis forsøgt Maalinger af Temperaturen i Havets Dyb, men i Forhold til Gjenstandens Storhed ere disse Resultater kun at betragte som de første Vink om de sande Forhold.

Hvad de fysiske Forhold angaar, have de Franske, og i langt højere Grad de Svenske Spidsbergens-Expeditioner foretaget Lodninger mellem Norge og Spidsbergen samt langs denne Øgruppes Vestside, der vise, at der mellem de nævnte Lande ikke er dybere end 270 Favne, og Lodninger fra flere Tyske Expeditioner have godtgjort, at hele Østishavet mellem Norge, Spidsbergen, Novaja Semlja og Nord-Rusland danner et eneste Flak, der grunder op mod disse Landes Kyster.

On the 19th of March 1874, Professors H. Mohn and G. O. Sars memorialized the Home Department of His Norwegian Majesty's Government as follows: —

A careful study of the physical and biological conditions peculiar to our native country, has convinced us that the means whereby to comprehend and explain them must be sought chiefly in a thorough exploration of the Sea stretching between Norway, the Færoe Islands, Iceland, Jan Mayen, and Spitzbergen. This part of the Ocean constitutes a wide basin, in which the warm water of the Atlantic meets the cold indraught from the Polar Seas. Our present knowledge of this ocean-tract refers principally to the margin of the basin, and is in greater part a result of Expeditions despatched by foreign countries. Thus, for instance, the various Swedish and French Expeditions to Spitzbergen have contributed very materially to furnish information concerning the eastern margin of the basin, and those sent out from England with the "Lightning" and the "Porcupine," in 1869 and 1870, have, as regards the south-western margin, between Scotland and the Færoe Islands, supplied data that may be said to mark an epoch in the history of marine research. The strip of ocean immediately adjacent to the Norwegian coast, has been investigated partly by our zoologists in the course of their labours, and partly on the annual expeditions of the Coast Survey, with the steamship "Hansteen." But as to the open sea, what we as yet know is meagre in the extreme. True, meteorological observations have, since 1867, been taken every spring by captains of Norwegian sealers, who now and again will make attempt to determine the temperature in the depths of the ocean; but such results must, compared to the magnitude of the problem, be regarded as mere intimations of the truth.

With respect to physical conditions, soundings were effected on the French, and more especially on the Swedish, Spitzbergen Expeditions, between Norway and Spitzbergen and along the western shores of that group of islands, showing the depth of the ocean between the said countries to be nowhere greater than 270 fathoms; and from soundings taken on divers German Expeditions, the whole eastern section of the Arctic Ocean is known to constitute an immense flat, shoaling gradually up to the coasts of Norway, Spitzbergen, Novaja Zemlja, and Northern Russia.

Vestenfor Linien mellem Tromsø og Spidsbergen og vestenfor samt nordenfor denne Ø styrter derimod Bunden sig ned til et stort Dyb, der midt imellem Spidsbergen og Grønland maaler 2650 Favne, en Dybde, der rivaliserer med selve Atlanterhavets. Fra den nordlige Side af Bassinet haves ingen Lodninger; kun ved man, at den vulkanske Ø Jan Mayen styrter sig meget brat ned i Havet. Heller ikke ved man, hverken hvorledes Bankerne paa Islands Vestkyst eller Flakket mellem Island og Færøerne gaa over til Ishavsdybet. Forholdene mellem Færøerne og Skotland ere derimod nøie undersøgte af "Porcupine"-Expeditionen i 1869. Her gaar fra Ishavet en smal Rende paa 600 Favnes Dyb ned i Atlanterhavet. Denne Rende samt den formodentlig dybe Rende mellem Island og Grønland synes at være de eneste Communicationsveje i Dybet mellem Atlanterhavet og vort Ishav. Paa den norske Side strækker Kundskaben om Havbundens Form sig saagodtsom ikke udenfor de af Fiskerne besøgte og af "Hansteen"-Expeditionerne oploddede Banker. Kun paa et eneste Sted, ved Storeggen, have disse Lodninger antruffet en rask Heldning af Bunden ud mod det store Hav-Bassin. Ellers ere vi totalt uvidende om, paa hvilken Maade vor Kysts Banker gaa over i Ishavsdybet, om det sker brat, eller langsomt, om det sker nær Kysten eller om det først finder Sted langt ude i Søen. Kundskaben om dette Punkt er det netop, som vi maa anse det for et Hovedpunkt at vinde.

Med Hensyn til Temperaturen i det her omtalte Strøg af Havet er vor Kundskab indskrænket omtrent til de samme Localiteter, som de hvor Dybdeforholdene ere undersøgte. Temperaturmaalingerne fra vor Kyst vise, at vore Banker og vore Fjordes tildels store Dyb dækkes af Vand, hvis forholdsvis høje Varmegrad viser hen til Atlanterhavet som dets Udspring. Intetsteds langs Norges Kyst er der paa Bankerne eller Fjordenes Bund fundet Kuldegrader. Saadanne ere derimod fundne ikke alene saavel i Overfladen som i Dybet ude i Havbassinets centrale Del og henimod dets vestlige Rand, men ogsaa i den dybe Rende mellem Færøerne og Shetland allerede i 300 Favnes Dyb.

Hvor langt vi maa gaa ud i Havet vestenfor Norge forat træffe paa iskoldt Vand paa Bunden, derom staa vi aldeles blottet for Kundskab. Her staa vi atter ved et Hovedpunkt, thi denne Grændse mellem det varme Atlanterhavsvand og det iskolde Polarvand maa, efter det hvad der kan sluttes af lignende Forhold, betegne Grændsen for de i Havet levende Væseners forskjellige Udbredelse til den ene eller til den anden Side. End ringere end vor Kundskab om Dybde- og Varmeforhold er vor Kundskab om Strømforhold, der spiller en saa stor Rolle i Dyrelivet, om Havvandets Bestanddele, der er af lige Vigtighed, og om de jordmagnetiske Forhold, der for Theorien som for Skibsfarten er af sær Betydning.

West of a line extending between Tromsø and Spitzbergen, as also west and north of the latter locality, the bottom sinks to a great depth, reaching between Spitzbergen and Greenland 2650 fathoms, and accordingly rivalling that of the Atlantic itself. Along the northern boundary of the basin no soundings have as yet been taken; all we know is, that the volcanic island of Jan Mayen plunges precipitately into the ocean. Nor is it yet known how or where the banks on the west coast of Iceland and the flat between Iceland and the Færoe Islands, pass into the depths of the Arctic Ocean. The section stretching between the Færoe Islands and Scotland, was, on the other hand, carefully explored on the "Porcupine" Expedition, in 1869. In this tract, a narrow channel, 600 fathoms deep, extends from the Arctic Ocean to the Atlantic. This channel, and probably too the deep channel between Iceland and Greenland, would appear to be the only highways by which the depths of the Atlantic are connected with those of the Arctic Ocean. Along the Norwegian coast, what we know of the nature and contour of the bottom is almost exclusively confined to that of the banks periodically visited by fishermen, and which of late years have been investigated on the Coast Survey expeditions with the "Hansteen." In but one locality — off the Storeggen bank — was the bottom found to sink rapidly down to the great ocean-basin. With this exception, we are totally ignorant as to how and where the banks lying off the coast of this country pass into the depths of the Atlantic, whether gradually or precipitately, whether in close proximity to the coast or possibly in mid-ocean. Now, the solution of this problem appears to us of the greatest importance.

As regards the temperature throughout the aforesaid ocean-tract, it is known only for most of the localities in which the depth has been measured. The comparatively high temperature distinguishing the water on our coastal banks and in our fjords, many of which are of great depth, points to the Atlantic Ocean as the source whence it is derived. Nowhere along the coast of Norway, whether on the banks or at the bottom of the deepest fjords, has 0° been observed; but in the central part of the ocean-basin, and at its western margin, the temperature has been found to be below zero, both at the surface and in the depths; nay, in the deep channel between the Shetlands and the Færoe Islands 0° is reached at a depth of 300 fathoms.

At what distance from the western shores of Norway the glacial bottom-area commences, we are unable to infer from the data as yet obtained. Here, then, we stand in face of another highly important question; for the limit at which the warm water of the Atlantic meets the cold indraught from the Polar Sea, must, reasoning from analogy, mark the limit of distribution for the animals inhabiting the warm and cold areas. But, trifling as is our knowledge of depth and temperature in that ocean-region, we know still less concerning the nature of its currents, — a physical condition which everywhere exerts such great influence on the character of the marine fauna, — concerning the chemical constituents of its water, — no less important in

Af hvad vi hidtil vide om det Hav, som omgiver Norges Kyster, kunne vi erkjende, at det er dette Hav, hvem vort Land skylder sin Existents som beboet og som civiliseret Land. Gaar man til de samme Breddegrader i Asien eller Amerika, træffer man kun Is-Ørkener, der sparsomt beboes af nomadiske Folkestammer. Det milde Klima, som i Norge gjør Landbruget, vor vigtigste Næringsvej, mulig, skyldes det varme Hav, som beskyller vore Kyster. Dette Havs Varme er ikke indskrænket til Overfladen: i saa Fald vilde dets Varmekraft snart være forbrugt under den lange Vinter; men, som anført, findes paa Kystens Banker og Fjordenes Dyb varmt Vand, der gjennem den lange Vinter, naar den koldere Luft stadig trækker Varme fra det varmere Vand, er det Reservoir eller den Ovn, som stadig forsyner Luften med Varme, og hvis Varmemængde er saa stor, at den holder ud den strengeste Vinter uden at tabe noget merkeligt af sin Varmeevne. Udenfor Bankerne have vi i Dybet Ishavets iskolde Vande, der fylde Færø-Shetlands-Rendens nederste Halvdel. Mod disses Indtrængen til Landet danne Bankerne den beskyttende Vold, de holde de iskolde Vande langt borte fra Kysten og hindre dem fra at trænge ind i vore Fjordes Dyb. Uden disse Banker skulde vi visselig i Norge have Grønlands Klima. Bankernes Udstrækning mod Vest eller Nordvest er saaledes en capital Sag for hele vor Tilværelse — men hidtil er den os ganske ubekjendt. De varme Vande, der flyde nordover fra Atlanterhavet, have en stadig Tendents til at gaa til højre, altsaa til at kaste sig ind paa Europas Vestkyst. Her møde de vore Banker, over hvilke de flyde. Denne Omstændighed er af den største Betydning. Thi Exempler fra andre Steder, f. Ex. fra Færø-Shetland-Renden, vise, at hvor de varme Vande flyde over et Underlag af iskoldt Vand, foregaar der fra dette en sterk Afkjøling, der endog naar til Overfladen, og saaledes bidrager til at gjøre Klimatet koldere. Men hvor det varme Vand flyder over en Landbund, der tjener denne til at bevare dets Varme i lange Strækninger. Det skyldes derfor vore Bankers Udstrækning, at Atlanterhavets varme Vande uden nogen sterk Afkjøling kunne omslynge vore Kyster helt op til Grændsen mod Rusland og videre. Den Udholdenhed, som det varme Vand har til at modstaa Vinterens Strenghed, beror foruden paa Landbundens, det er Bankernes, Udstrækning ogsaa paa deres Dybde — men derom have vi ikke Kundskab uden for den smale Rands Vedkommende, som de senere Aars Dyblodninger langs Kysten har skaffet os Kundskab om.

their operation, — and finally, concerning the phenomena of terrestrial magnetism, which, bearing as they do alike on science generally and on practical navigation, are of peculiar significance.

From the facts as yet determined respecting the sea that laves our shores, we may safely assume, that to its waters is Norway indebted for her existence as a habitable and civilised country. In Asia and America, the land within the same parallels of latitude constitutes a vast icy waste, thinly peopled by nomade tribes. The mild climate of Norway, indispensable for the prosecution of agriculture, whereby the great bulk of the population subsists, depends mainly upon the high temperature of the sea surrounding our coast. The heat given off by the water is not derived exclusively from the surface; were such the case, its source would soon be exhausted during the long northern winter; but, as previously stated, water of a high temperature is found on the banks and in the depths of the fjords, which, throughout the long winter, when the cold air is incessantly drawing off heat from the sea, constitutes, so to speak, a reservoir whence the atmosphere is supplied with heat; and the amount in store is much too great to admit of being sensibly reduced by the longest and most rigorous of winters. Without the banks, we have the cold water from the Arctic Ocean, filling the lower half of the channel between the Færoe and the Shetland Islands. Now, it is these banks that form a protective barrier, effectually preventing the cold water from forcing a passage to the coast, and from mingling its waters with those in the depths of our fjords. Deprived of these banks, Norway would assuredly have the climate of Greenland. Hence their extent in a westerly or north-westerly direction is a question of vital importance to the people of Norway, yet concerning which we have at present everything to learn. On its northward course, there is a marked tendency in the warm Atlantic water to keep to the right and bank up against the western coast of Europe. Here it reaches our banks, over which it passes. But this is a most important fact; for whenever a warm current flows over a substratum of cold water, as is the case in the channel extending between the Shetlands and the Færoe Islands, it parts with a considerable portion of its heat, being cooled up to the surface, and thus contributes towards the severity of the climate; but where the warm water flows directly over the bottom, it will retain its heat for a very considerable distance. Hence it is the magnitude and extent of our banks that enables the warm water of the Atlantic, without being deprived of any great amount of heat, to compass our shores as far north as, nay farther than, the Russian frontier. The tenacity evinced by this water in retaining its high temperature, how intense and protracted soever may be the cold, is due, not only to its flowing for a long distance in immediate contact with the bottom, or to the extent of the banks, but likewise to the depth in those localities. As regards these conditions, however, all that we know has reference solely to the narrow belt along the coast in which of late years soundings have been taken.

Med Hensyn til Dyrelivets Forhold i den omhandlede Havstrækning er vor Kundskab omtrent paa det samme Trin som med Hensyn til de fysiske Forhold. Denne Havstrækning er hidtil saagodtsom slet ikke undersøgt og meget synes at lade formode, at Dyrelivet her saavel oppe i Søen som paa de største Dyb vil vise sig særdeles rigt udviklet. Navnlig vil der til de paa de store Dybder (som her gaa ned til over 2000 Favne) levende Dyrformer knytte sig en ganske særlig Interesse ikke blot i zôologisk men ogsaa i geologisk Henseende, da det allerede har vist sig, at saadanne Dybvandsdyr ofte kunne aabne os ganske uventede Indblik i vor Jordklodes tidligere Forandringer. Det lidet vi til Dato kjende om de fysiske Forhold i den omtalte Havstrækning, tør nu ogsaa lade os formode, at der efter al Sandsynlighed her vil findes et rigere og mere varieret Dyreliv i Dybet, end maaske i nogen anden Del af Verdenshavene, og at man derfor netop her lettest vil kunne faa løst mange endnu uafgjorte Spørgsmaal vedkommende Dyrelivets Udbredning i Havets Dybder og Forhold til tidligere Jordperioders Dyreliv. De engelske Expeditioner med "Lightning" og "Porcupine" have allerede tilstrækkeligt vist os, hvilket vidt Felt for fremtidige Undersøgelser, berørende de vigtigste Spørgsmaal i Naturvidenskaben, der her ligger aabent for os, og det er ganske naturligt, at den videnskabelige Verden ogsaa venter, at der fra vort Lands Side skal gjøres noget til Fremme af en Sag, der er af saa stor Betydning for Videnskaben og hvori allerede saa mange Nationer have taget virksom Del.

Vi have ogsaa en dobbelt Opfordring hertil, da der ved Siden af de rent videnskabelige Resultater ogsaa kan ventes opnaaet Resultater af stor praktisk Betydning for vort Land. At Undersøgelserne af de fysiske Forhold i denne Havstrækning vil give vigtige Bidrag til Bedømmelsen af Vejrforholdene langs vor meget befærdede Vestkyst og derved altsaa komme Kystbefolkningen tilgode under dens haarde og farlige Bedrift tilsøs, er vel utvivlsomt. Ogsaa er det at vente, at mange Spørgsmaal vedkommende vore vigtigste Fiskerier herved vil kunne løses. Navnlig gjælder dette de for vort Land saa vigtige Sildefiskerier. Som allerede Undertegnede Sars har udtalt, er der al Sandsynlighed for, at de store Sildemasser, der om Vinteren og Vaaren besøge vore Kyster, netop have sit egentlige Tilhold i den omtalte Havstrækning, og at de Variationer, som gjennem Tidernes Løb ere iagttagne ved Vaarsildfiskerierne, væsentlig afhænge af og betinges af de forskjellige meteorologiske Forhold i det udenfor liggende Hav.

Den store saavel videnskabelige som praktiske Interesse, der saaledes knytter sig til Kundskaben om vort Vesterhavs Naturforhold, gjør det i mange Henseender ønskeligt, at en saadan Kundskab erhverves saa snart og saa fuldstændigt som muligt. En gradevis Fremgangsmaade med Benyttelse af de forhaandenværende Hjelpemidler vil

Of the fauna inhabiting the tract of ocean referred to in this Memorial, our present knowledge is no less limited than of its physical conditions. This extensive region has never yet been made the field of zoological investigation; and there is much to warrant our assuming, that the animal life prevailing there will prove to be distinguished alike at the surface and in the greatest depths by a high degree of development. And moreover, peculiar interest will attach to forms of animal life occurring in the great depths (upwards of 2000 fathoms), not only from a zoological, but also from a geological point of view, inasmuch as deep-sea animals have frequently afforded an unexpected insight into the earlier transformations of our planet. From the little at present known of the physical conditions distinguishing the aforesaid ocean-tract, we may infer, that, inhabiting its depths, will be in all probability found a fauna more extensive and varied than, perhaps, in any other part of the ocean; and hence that we may rely on its furnishing exceptional facilities for the elucidation of many still unsettled questions touching the occurrence of deep-sea animals, and the conditions affecting animal life in former geological periods. The results of the British Expeditions with the "Lightning" and the "Porcupine" have shown us how wide a field of research this subject opens, bearing as it does on the weightiest problems in Physics and Natural History; and it is but natural that our country should now be expected to contribute her quota towards the advancement of a cause so important to the interests of Science, and in which so many nations have already taken active part.

Besides, we have in this case an additional motive to impel us, since, apart from scientific expectations, there is reason to conclude that great material advantage would accrue to the country at large. Thus, for instance, a thorough investigation of the physical conditions peculiar to the said ocean-tract, must very materially assist in throwing light upon the meteorological influences so potent in determining the weather on our western shores, and thereby render special service to the coastal population when engaged in their arduous avocations. Moreover, many now open questions affecting the most important of our fisheries, would, we may reasonably opine, be elucidated. This refers in particular to the great periodical herring-fisheries. As already suggested by one of your memorialists (Sars), it is in all probability this tract of ocean within which lie the true haunts of those enormous shoals of herrings that in the winter and spring annually repair to our shores; and the marked irregularity of occurrence, observed, in the course of years, after a longer or shorter interval, to distinguish these fisheries, may no doubt be traced to meteorological influence at work off the coast.

Hence, as very great benefit would assuredly result alike to Science and to the material interests of the nation from an intimate knowledge of the physical and biological conditions distinguishing the Norwegian Seas, the sooner and the fuller, in our judgment, that knowledge be acquired, the better. A gradual mode of procedure, using

her ikke strække langt til. De norske Skibe, som fortrinsvis besøge disse Farvande, ere Sælfangerne. Fra disse kan man fremdeles vente Bidrag til Kundskab om Havets Vejrforhold, der efterhaanden vilde sætte os istand til at lære disse vigtige Momenter for Dyrelivet og Havboernes Vandring at kjende. Sælfangernes Ophold i disse Egne foregaar dog kun til en Del af Aaret, Marts til Juni, og tildels langt Nord og inde i den med Drivis belagte Del af Havet, som udgjør den allernordligste Del af det Felt, hvortil vi her sigte. Endel norske Fartøjer fare tildels et godt Stykke udenfor Kysten til og fra Arkhangel om Sommeren. Ogsaa fra en Del af disse kunde man erholde meteorologiske Iagttagelser. Hvad der paa denne Maade kunde indvindes af Oplysninger, vil det meteorologiske Institut bestræbe sig for at lade komme til Nytte for den attraaede Kundskab om Havets Vejrforhold. Videre end til saadanne Iagttagelser kunne Handelsmarinens Bestræbelser ikke naa. Det har vist sig, at der med Maalingen af Havets Temperatur i Dybet om Vinteren for Sælfangerne er forbunden særegne Vanskeligheder, der have gjort mere end en Skibsførers ufortrødne Bestræbelser til Intet. Mere kunde vistnok udrettes, om en Videnskabsmand medfulgte et saadant Fartøj. Men da denne ikke kunde dirigere Skibet hen til de Steder, hvor hans Undersøgelser vilde være af størst Interesse, og Sælfangerne, som nævnt, opholde sig den meste Tid udenfor det Felt, der nærmest skulde være Gjenstand for den mest lovende Undersøgelse, vil ogsaa et saadant Middel blive for kortrækkende.

Vi blive saaledes staaende ved den Overbevisning, at Undersøgelsen af Havet vestenfor Norge, for at blive effectiv, maa udføres ved en dertil bestemt og udrustet videnskabelig Expedition. Som Forbillede for en saadan staa de Britiske Expeditioner med "Porcupine" og "Challenger". Den sidste, der gjælder alle de store Verdenshave og har en stor kraftig Dampcorvet til sin Disposition, er udrustet med alt hvad der til dens Øjemed kan fordres og er sit Land i enhver Henseende værdig. Saa storartet et Apparat vil til Undersøgelsen af vort Hav ikke være nødvendigt. Vi ville i enhver Henseende være hjulpne med en Expedition saadan som den med "Porcupine".

Fra den Norske Stats Side har der, uagtet saamange af vore Interesser knytte sig til Havet, ikke været foretaget nogen Expedition af videnskabelig Art til de os allernærmest omgivende Have. Undersøgelsen af de for vore nordlige Egne saa vigtige Fangstfelter i Nordishavet har ene og alene været overladt til den private Foretagsomhed, som her foruden de rent praktiske Resultater have medbragt skjønne Resultater for Videnskaben, saavel for Geografien som for Naturvidenskaben. Vi kunne nævne Carlsens Omsejling af Spidsbergen, hans Indtrængen i det kariske Hav, hans og Tobiesens samt senere Altmanns, Nilsens og

to their full extent the limited means now at our disposal, would certainly fail of its object. The Norwegian vessels that navigate those regions are mostly sealers. From this source we may indeed still hope to learn further valuable particulars of meteorological phenomena, which may eventually lead us to a juster estimate of their influence on animal life and the migratory instincts observed in the inhabitants of the deep. Meanwhile, the sojourn of our sealing-ships in those high latitudes is confined to part of the year only (from March to June), the vessels keeping, too, nearly the whole time, among the drift-ice, which constitutes the extreme northerly limit of the tract referred to. Moreover, the Norwegian ships that trade to Archangel, and which could also furnish meteorological observations from the open sea, do not extend their voyages beyond the summer months. Of all information from these sources, the Meteorological Institute will of course take advantage, to extend our knowledge of the causes determining the weather at sea. With other and more intricate observations it does not lie in the power of the merchant-navy to furnish us. Observing the temperature at any considerable depth in winter, is attended with very great difficulty, so great indeed as to have rendered worthless more than one captain's indefatigable exertions. True, greater results might be obtained were a gentleman whose profession was science to accompany such a vessel; but even in that case he could not shape her course and visit the best localities for observations; besides, the Norwegian sealers keep most of the season without the tract which, in preference to any other section of those Northern Seas, it is desirable to select as the field of exploratory research; and hence the alternative offered has little to advocate its adoption.

In face of the facts set forth above, we will emphasize our previously expressed conviction, that, in order to investigate effectively the tract of ocean stretching west of the shores of Norway, a special expedition must be despatched. As models we have the "Porcupine" and "Challenger" Expeditions. The latter, which has for its object the exploration of the great Oceans of the globe, is furnished with a powerful steam-corvette, has been fitted out on a scale commensurate with its importance, and is in every way worthy of the British Nation. But means so extensive and costly are not required for investigating the Norwegian Seas; an Expedition similar, for instance, to that sent out with the "Porcupine," would certainly be adequate for the attainment of the end proposed.

Though so many of our national interests are directly connected with the sea, no Scientific Expedition has yet been undertaken by the State to those parts of the ocean that lie next adjacent to the Norwegian coast. The exploration of the extensive sealing-grounds in the Arctic Ocean has been left altogether to private enterprise, which, apart from merely practical results, has enriched Science in the several branches of geography, physics, and natural history. As a few instances in point, we have only to mention Carlsen's circumnavigation of Spitzbergen, his exploring voyage far into the Kara Sea, and the discovery,

Johnsens Opdagelse af Kong Karl-Land, der saa længe svævede som en Taage for Geograferne, Tobiesens Iagttagelser fra Overvintringer paa Bjørne-Øen og paa Novaja Semlja, Johansens og Macks Omseiling af Novaja Semlja og Opdagelse af det varme Vand udenfor Obs og Jeniseis Mundinger. Ved disse Resultater har Norge kunnet hævde en Plads som Deltager i de Opdagelser, hvormed en Række af Nationer have bidraget til at sprede Lys over vor Planets nordligste Egne, og denne Plads har været en ærefuld selv ved Siden af de rigere Nationer med deres ganske anderledes vel udrustede offentlige og private Expeditioner.

Imidlertid tro vi, at Udrustningen af en egentlig Nordpol-Expedition, med det Maal at trænge frem i hidtil uudforskede Polar-Egne, ikke bliver vor Sag. Dette maa vi overlade til de rigere Nationer. Men naar der lige udenfor vor Kyst ligger et Hav, der indeslutter Ophavet til hele vor Existents, og dette Hav hidtil er saagodtsom ganske ukjendt i dets Naturforhold, da ligger Undersøgelsen af disse os Nordmænd nær og nærmere end nogen anden.

En videnskabelig Undersøgelse af Havet udenfor Norges Vestkyst er en Opgave, som fra norsk Side visselig skulde kunne udføres med samme Held som de Britiske Expeditioner af samme Art. Den maatte gaa ud paa at undersøge Havets Dybde, dets Temperatur, dets Vands chemiske Sammensætning og Gasindhold, dets Strømninger saavel i Overfladen som i Dybet, Bundens Beskaffenhed og geologiske Formation, dets Vejrforhold, de magnetiske Forhold og særlig dets Dyre- og Planteverden af enhver Art. Som Resultater af en saadan Undersøgelse kan man vente at erholde Oplysning om alle de Naturforhold, der betinge vort Lands Klima med dets Variationer og fremfor Alt om vore vandrende Fiskearters biologiske Forhold. Af hvilken Interesse saadanne Resultater vilde være for den hele Naturvidenskab, skulle vi ikke her videre udbrede os over; alene de vigtige Resultater, som kunne gjøres Regning paa for vore Fiskerier forekommer det os at være nok at henpege paa for at motivere en saadan Undersøgelses Ønskelighed. En til en saadan Undersøgelse udsendt Expedition maatte gaa ud fra den norske Kyst nordenfor Stat som sin Basis, og fra denne af studere Forholdene ud over Bankerne lige til selve Ishavsdybet, en Opgave, som den for Dampskibet "Hansteens" Oplodninger lagte Plan ikke tillader dette at udføre, paa samme Tid som "Hansteens" Arbeider ville bidrage i højeste Grad til at støtte den til Havets Undersøgelse udsendte Expeditions Arbeider. En anden Tilslutning vilde Hav-Expeditionen have til de Britiske Expeditioners Arbejde, navnlig til "Porcupine"-Expeditionens. Den vilde give denne, der nærmest er at anse for en Pioner-Expedition paa disse Felter, den rigtige Udvidelse og Afrunding i Retning af Polarhavet og saaledes mødes med al mulig Sympathi af de Britiske For-

first by that enterprising seaman and Tobiesen, and, some years later, by Altmann, Nilsen, and Johnsen, of Kong Karl's (Wyche) Land, which had so long flitted mirage-like before the minds of geographers; Tobiesen's valuable observations, taken when wintering on Beeren-Eiland, and on Novaja Zemlja; Johansen's and Mack's circumnavigation of Novaja Zemlja, and their discovery of the warm surface-water off the mouths of the Ob and the Yenisei. The exertions of these Norwegian mariners have given to their country her full share in the discoveries that have helped to throw light on the most northerly regions of the globe, thus securing to her an honourable position by the side of wealthier nations, with their numerous Expeditions, either fitted out at the expense of the State or by private munificence.

Meanwhile, a "North-Pole Expedition," having for its object the exploration of unknown Arctic regions, does not, we conceive, come within the scope of Norwegian enterprise. Such an undertaking must be left to nations better able to make the pecuniary sacrifice it would entail. But, off our coasts extends a tract of ocean which is the origin and preserver of our existence as a civilised nation; and that expanse of sea being as regards its physical conditions well nigh unknown, on Norway should first devolve the labour of their solution.

A scientific exploration of the sea west of Norway might certainly be accomplished by Norwegians with success equal to that which has attended the like British Expeditions. It would comprise the depth of the sea, its temperature, the chemical composition of its water, the currents prevailing there, both at the surface and in the depths, the nature and geological formation of the bottom, meteorological and magnetical phenomena, and more especially all forms of animal and vegetable life. The results of such an investigation might be expected to throw light upon the physical conditions determining our climate, and, above all, upon the biological characteristics of our migratory fishes. What value the acquirement of such information would have for Science generally, we will not dwell upon here; the great advantage which in all probability our fisheries would reap is alone sufficient to show the importance of such an undertaking. An Expedition with the object here set forth, would have as its basis the Norwegian coast north of Stat, and from this locality would proceed to investigate the banks, exploring thence down to the deepest parts of the basin, — a scheme that does not come within the limits of the plan laid down for the sounding-operations of the Coast Survey with the "Hansteen," the results of which would, however, very materially contribute to facilitate the scientific work of the Expedition. Moreover, a Norwegian Expedition must derive additional importance from its intimate relation to British Expeditions, and more especially to that despatched with the "Porcupine," since it would furnish the very desirable opportunity of carrying on and completing in the direction of the Arctic Ocean the work begun by the "Porcupine" Expedition (which bore a true pioneering character), and hence be met with the warmest sympathy

skere. Herom have vi allerede modtaget Vidnesbyrd fra disse Kanter. Paa samme Tid have vi og bragt i Erfaring, at den Britiske Regjering ikke agter at lade „Challenger" overtage denne Undersøgelse af vort Ishavsbækken, som vi her have for Øie.

Til Udførelse af Expeditionens Arbejder kræves en Zoolog med et Par Assistenter, en Fysiker og en Chemiker, forsaavidt det Videnskabelige angaar. Til Arbejdstid maatte vælges de roligste Sommermaaneder, thi med uroligt Hav er Arbejdet i de fleste Retninger umuligt. $2^1/_2$ Maaned, fra Midten af Juni til Slutningen af August er den længste Arbejdstid, man kunde gjøre Regning paa, og af denne Tid vilde mange Dage ikke kunne benyttes, naar Vejret er uroligt.

Af de til Expeditionen fornødne Apparater er Skibet det vigtigste og kostbareste. Et saadant maatte være et Dampskib, der besad tilstrækkelig Kraft til at manøvreres for Maskinen i ethvert saadant Vejr, hvori Undersøgelser af Havdybet overhovedet kunde foretages; det maatte kunne medtage Kul for en længere Tid og have en brændebesparende Maskine, have flere Baade til forskjellige Undersøgelser og et tilstrækkeligt Mandskab til Udførelse af alle med Dybvandsundersøgelser forbundne, ikke ganske lette Arbejder. Til disse udfordres ogsaa et Dampspil. Desuden udfordres et Arbejdsrum for de videnskabelige Undersøgelser, som kunne udføres ombord.

Efter de Undersøgelser, vi ved Sagkyndiges Hjelp have anstillet, findes der blandt norske Dampfartøjer for Tiden ikke noget, som opfylder de nævnte Betingelser. Med Hensyn til Tilvejbringelse af et passende Fartøj for Expeditionen stiller der sig nu trende Alternativer.

A. Anskaffelsen af et nyt Skib. Med Hensyn til dette Punkt ere vi saa heldige at kunne nævne et Overslag over dets Kostende, som er blevet os velvillig meddelt af Nylands mekaniske Verksted. Dette Verksted har nemlig fra den russiske Regjering modtaget Opfordring til at udarbejde Overslag over Omkostningerne ved Anskaffelse af et nyt Jerndampskib, med Skrue, skikket til Opsyns- og Opmaalingsfartøj, af en Størrelse og med en Udrustning og Indredning, som paa det allernærmeste falder sammen med, hvad vi efter Samraad med Sagkyndige anse passende for en Expedition som den af os her omhandlede. Et saadant Skib vilde efter Nylands Verksteds Overslag, med fuld Udrustning, Dampspil, Baade, Høj- og Lavtryks-Maskine af fuld Kraft for Fartøjet, koste 40,000 til 45,000 Spd. efter Nutidens Priser.

B. Den Krigsmarinen tilhørende Skrueskonnert „Alfen", som man havde tænkt at sælge, kunde med en passende Omforandring blive et for Expeditionen hensigtsmæssigt Skib. Naar man forsynede Fartøjet med ny hensigtsmæssigere og større Skrue, en ny større og sterkere Kjedel,

on the part of British *savants*. Of this we have already received assurance. We are also able to state, that the basin of the Arctic Ocean will not be investigated by the "Challenger" Expedition.

The scientific work involved in such an undertaking, would call for the services of a naturalist, with one or two assistants, a physicist, and a chemist. As regards the most fitting season of the year for the cruises of the Expedition, this would be obviously the finest summer months; for in rough weather the greater part of the work of which there can be question is utterly impracticable. Two months and a half — from the middle of June to the end of August — might be reasonably calculated upon, including of course many stormy days on which nothing could be done.

Of all that is needed for the Expedition, the choice of a vessel would be the chief consideration, as her acquisition would involve the greatest outlay. She should be a steamer, with an engine sufficiently powerful to admit of working her in any weather that did not render the exploration of the ocean-depths altogether impracticable; she must, too, be able to take out coals for a considerable period, have an engine specially adapted for economising fuel, be provided with several boats, in which, when occasion called, to put off from the ship, and moreover be manned by a crew sufficiently numerous to do all the work connected with sounding, dredging, trawling, &c. which, being mostly of a laborious character, would require a steam-winch for its effective execution. Finally, there must be room on board for instituting such observations and experiments as admit of being undertaken at sea.

Having made inquiry of persons specially conversant with the subject, we are in a position to state, that, at the present moment, there is no Norwegian steamer that fulfils the conditions specified above. Now, as regards the acquisition of a vessel for the proposed Expedition, choice can be made between three alternatives.

A. The purchase of a new vessel. With respect to this alternative, we are in possession of an estimate, kindly furnished by the Manager of the Nyland Mechanical Works. The said Works have been requested by the Russian Government to give an estimate of the cost of an iron screw-steamer for the Coast Survey of that country, which, as regards burden, tackling, and general equipment corresponds very nearly with the description of vessel that we, having duly consulted experts, believe to be most suitable for the Expedition proposed in this Memorial. Such a steamship, fully equipped, with compound engines, steamwinch, boats, &c., could, as prices now stand, according to the estimate of the Nyland Works, be built for a sum of from Spd. 40,000 to Spd. 45,000.

B. The screw-schooner "Alfen," belonging to the Royal Navy, which was to have been sold, might, by sufficiently extensive alterations, be made a suitable ship for the Expedition. Furnished with a new and improved propeller of increased dimensions, with larger and stronger

formindskede Riggen og foretog Forandringer ved Apteringen, saaledes at der blev Plads for de til Expeditionen hørende Videnskabsmænd og deres Arbejder, foruden til Officierer og Mandskab samt stort Rum til Kul, vilde man faa et Fartøj, som i saadant Vejr, som udfordres til de videnskabelige Arbejder, kunde manøvreres fuldstændigt for Maskinen, og i mere uroligt Vejr kunde manøvreres som Sejlskib, hvorved Betingelserne altsaa vare givne for den størst mulige Kulbesparelse og Kulbeholdningens Forslag for en længere Tid, noget som var nødvendigt for Expeditionens Arbejder ude paa det aabne Hav langt fra Kuldepot. Omkostningerne ved en saadan Forandring er af Nylands Verksted beregnet til 17,000 Spd. Skulde tillige ny Maskine udfordres, hvad der neppe er nødvendigt, ville Udgifterne stige til henimod 25,000 Spd.

C. Man kunde leje et Dampskib for den Tid, der var nødvendig for Expeditionen hver Sommer, saa længe den varede. Omkostningerne herved er det ikke muligt at opgive, da disse dels ville bero paa Conjuncturerne, dels være afhængige af de Indredninger, som Fartøjet nødvendig maatte gives, for at være skikket til Expeditionsfartøj.

Af disse tre Alternativer er det første det mest anbefalelsesværdige, da det vilde give den største Frihed med Hensyn til det hele Arrangement. I denne Henseende er man noget bundet ved Alternativ *B*, og i højeste Grad ved Alternativ *C*. Ved dette sidste havde man endog den ubehagelige Risico, at maatte foretage nye Foranstaltninger for hver Gang, Expeditionen skulde udrustes, og kunde aldrig gjøre Regning paa hver Gang at faa beholde det samme Skib.

Næst Skibet udfordres der til Expeditionens Øjemed en hel Del Apparater, som Dybvandsliner til forskjelligt Brug (Temperatur, Skrabninger, Strømundersøgelser) Lodder, Patentblokke, Accumulatorer, Thermometre, Skraber, Net, fysiske (magnetiske) Apparater, Glas, Spiritus m. m. Efter velvillig Opgave af Capt. Davis af det Britiske Admiralitets hydrografiske Afdeling vil man kunne udruste et mindre Skib med de for Dybvandsundersøgelser nødvendige Apparater for en Sum af 1,000 til 1,200 Lstrl. eller 4,500 til 5,400 Spd.

Omkostningerne ved at holde Expeditionen ude, nemlig Hyre, Kost, Kul, Vedligeholdelse m. m. ere af Capitainlieutenant C. Petersen, der velvillig har bistaaet os ved Udarbeidelsen af disse Overslag, beregnede til 2000 Spd. pr. Maaned. Dette giver for en Tid af $2^1/_2$ Maaned en Sum af 5000 Spd. aarlig.

Hvormange Sommere, der ville medgaa, forend Expeditionens hele Øjemed var naaet, er det ikke muligt paa Forhaand at sige. Det kommer her saa meget an paa hvilke Forhold man ved Undersøgelserne finder og hvorledes Vejret arter sig. Vi tro dog, at man i 2 meget gun-

boilers, less heavily sparred, and fitted up below deck in such manner as to afford room alike for the personal accomodation of the members of the Expedition, and for such part of their work as could be done on board, as also for the officers and crew, together with stowage for coal, the "Alfen" would be a vessel which, in weather admitting of the scientific exploration of the ocean, might be worked as a steamer, and, in a heavier sea, as a sailing-ship, thus securing the conditions requisite for the greatest possible economy in the consumption of fuel, and for adjusting the stock of coal to the length of the period during which the Expedition would have to cruise in the open sea, far from any coaling-station. The cost of such alterations has been estimated by the Manager of the Nyland Works at Spd. 17,000. New engines — which however will hardly be wanted — would raise the outlay to about Spd. 25,000.

C. A steamer might be chartered every summer for the period over which the cruise of the Expedition would extend. As regards the cost, nothing definite can be stated, since the amount must depend partly on the state of the freight-market, and partly on the expense entailed by adapting the vessel to the requirements of the Expedition.

Of these three alternatives, the first is, in our judgment, the most desirable, admitting as it does of greater freedom in the general arrangement. The character of the second alternative, *B*, would, to some extent, be found restrictive in its operation; but the third alternative, *C*, might, if selected, lead to serious inconvenience and uncertainty, involving as it would the risk of new arrangements having to be made for each successive cruise, since the Expedition could hardly rely on being able to retain during the whole period of its duration the vessel originally chosen.

Next in importance to the ship, are the apparatus and appliances of various kinds with which the Expedition would have to be furnished, such as deep-sea lines for divers purposes (temperature, dredging, investigation of currents), sounding-leads, patent blocks, accumulators, thermometers, dredges, nets, physical (magnetical) instruments, glass jars, tubes, &c., and spirits of wine, &c., &c. According to a statement kindly furnished by Captain Davis of the Hydrographic Department of the British Admiralty, a vessel of moderate size might be fitted out with the instruments and apparatus necessary for such an Expedition at a cost of from 1000*l*. to 1200*l*. (Spd. 4500—5400).

As regards the current expenses of the Expedition, viz. for seamen's wages, rations, coal, wear and tear of vessel, &c. &c., these are put by Commander C. Petersen, R. N., who has kindly assisted in furnishing the above estimates, at Spd. 2000 a month. Hence, according to this calculation, the cost of a $2^1/_2$ months' cruise would be Spd. 5000.

How many summers would elapse ere the object of the Expedition had been fully attained, it is of course impossible to state beforehand, so much must necessarily depend on the proportions the investigation would assume, and on the weather. Meanwhile, your memorialists are of

stige eller 3 rimelige Sommere vil kunne have erhvervet et antageligt Udbytte fra den hele Havstrækning, hvorom her er Tale.

Af de til Dybvandsundersøgelserne hørende Apparater er der flere som maa fornyes hvert Aar. Efter Expeditionens Slutning bliver der dernæst Spørgsmaal om Midler til Resultaternes videnskabelige Bearbejdelse og deres Publication. Thi først naar denne foreligger, kan Foretagendet siges at være afsluttet. De hertil udfordrende Summer kunne vi ikke give noget Overslag over; de bero paa det Udbytte, som Expeditionen i Havet kan yde.

Vi have fremsat vore Anskuelser om Vigtigheden af en Undersøgelsesexpedition til Havet udenfor Norges Vestkyst og om Maaden, hvorpaa den kan udføres, i den Overbevisning, at denne Sags Fremme vil være et Foretagende, som vil bidrage mere end noget andet til at hævde vort Land den Plads i den videnskabelige Verden, som dets Beliggenhed og Naturforhold har anvist det, og som vil give de mest tilfredsstillende Oplysninger om Spørgsmaal, der vedrøre vort Lands materielle Velvære i mange Retninger. At et saadant Foretagende er forbundet med større Omkostninger, der dog ikke kunne ansees betydelige i Forhold til det forventede Udbytte, har ikke kunnet holde os tilbage fra at foreslaa Udførelsen af et Verk, som vi maa anse for at være i Fædrelandets høieste Interesse.

Vi tillade os derfor ærbødigst at henstille til det kongelige Departement at søge bevirket de nødvendige Pengemidler bevilgede til Udførelsen af en naturvidenskabelig Undersøgelsesexpedition til Havet mellem Norge, Færøerne, Island, Jan Mayen og Spidsbergen.

Christiania den 19de Marts 1874.

H. Mohn. **G. O. Sars.**

opinion that in 2 exceptionally favourable or in 3 average summer-seasons, the whole of the ocean-tract here referred to might be satisfactorily explored.

Several of the instruments and appliances would have to be renewed each cruise. At the close of the Expedition a further grant of money would be needed, for working up and publishing the results. The amount thus required to terminate the undertaking, we are not in a position to name, since it must obviously be proportioned to the general success of the Expedition.

We have set forth in this Memorial our views touching the great importance of an Expedition having for its object the exploration of the ocean-tract lying off the West Coast of Norway, and also as to the means for achieving it, — in the firm conviction that such an undertaking would contribute above any other to insure our country that rank among civilised nations which by reason of her geographical position and physical conditions she is entitled to hold: and moreover, that it must help to throw light on many intricate subjects closely connected with her material prosperity. That the projected Expedition will involve an outlay considerable indeed if not great compared with its probable results, has therefore failed to deter your memorialists from advocating the claims of an undertaking the speedy realisation of which they cannot but regard as a question profoundly affecting the interests of our country.

We venture therefore to hope, that the Home Department of His Majesty's Government will take the necessary steps to obtain a grant of money sufficient to defray the cost of an Expedition having for its object the scientific exploration of the ocean-tract stretching between Norway, the Færoe Islands, Iceland, Jan Mayen, and Spitzbergen.

Christiania, March 19th, 1874.

H. Mohn. **G. O. Sars.**

Over dette Forslag afæskede Departementet Betænkninger fra Directionen for den geografiske Opmaaling, det mathematisk-naturvidenskabelige Facultet ved Universitetet i Christiania, Børskomiteerne i Kristianssand, Bergen og Throndhjem, Opsynscheferne ved Vaarsildfiskeriet og ved Lofotfiskeriet, samt fra Directionen for Bergens Museum, ligesom det ogsaa henstillede til Marine-Departementet at udtale sig i Sagen, navnlig om Anskaffelse af Skib og om hvilken Myndighed dettes Udrustning og Bestyrelse burde bevirkes overdraget. Samtlige disse Autoriteter udtalte sig

Touching this proposal, the Home Department advised with the Directors of the Geograpical Survey, the Faculty of Sciences of the University of Christiania, the Exchange-Committees in Christiansand, Bergen, and Throndhjem, the Government Inspectors of the Spring Herring Fishery and of the Lofoten Cod Fishery, and with the Directors of the Bergen Museum; moreover, the Navy Department was also desired to pass opinion on the subject, more particularly as to how a suitable vessel might be procured, and what official body should have charge of the

for Expeditionens Istandbringelse og tiltraadte i det Væsentlige de af Forslagsstillerne udtalte Anskuelser.

Da Departementet for det Indre var enig i Marine-Departementets Udtalelse, at Expeditionens Bestyrelse eventuelt burde underlægges Directionen for den geografiske Opmaaling, anmodedes denne under 15de October 1874 om at indkomme med detaljeret Overslag over de Omkostninger, som Expeditionen vilde udkræve. Dette Overslag indsendte Direktionen under 8de Marts 1875, og under 23de samme Maaned indgik Regjeringen med underdanigst Instilling i Sagens Anledning. Da samtlige indhentede Betænkninger gik ud paa, at det vilde være hensigtsmæssigst, at der blev bygget et til Expeditionen særlig indrettet Fartoj, og da Directionen i sit ovennævnte Overslag ogsaa satte dette som første Alternativ, optoges det i Indstillingen, idet Departementet underdanigst androg om, at der for Storthinget maatte blive fremsat naadigst Proposition om Bevilgning af en Sum af 61,500 Spd. (246,000 Kroner) til Anskaffelse af Skib med Rig, af Instrumenter og Inventarium samt til forberedende Arbejder. Denne Indstilling blev bifaldt ved kongelig Resolution af 30te Marts 1875.

Den 20de og 21de Maj behandledes Sagen i Storthinget, hvis Beslutning gik ud paa, at Expeditionen skulde udføres med lejet Fartoj, idet følgende af Repræsentanten Haugland fremsatte Forslag vandt de fleste Stemmer:

"Til Anskaffelse af Apparater, Instrumenter m. V. samt til første Aars Drift af en videnskabelig Expedition til Undersøgelse af den Del af Atlanterhavet, der omsluttes af Norge, Færøerne, Island, Jan Mayen og Spidsbergen, bevilges for Budgetaaret fra 1ste Juli 1875 til 30te Juni 1876 indtil 20,000 Spd."

Da Expeditionens Udførelse saaledes var besluttet, blev Kaptein i Marinen *C. Wille*, der i en Række Aar havde ledet Dyblodningerne udenfor Norges Kyst som Chef for Oplodningsdampskibet "Hansteen", og som havde assisteret Opmaalingsdirectionen ved Udarbeidelsen af det ovennævnte Overslag over Expeditionens Kostende, af Departementet for det Indre overdraget Forberedelserne til dens Udrustning, hvilke tog sin Begyndelse 10 Dage efter at Storthingets Beslutning var faldt, med at Capt. Wille rejste til England, dels for at konferere med Chefen for "Challenger," Capt. Nares, der om kort Tid skulde afgaa med den Britiske Polar-Expedition, dels for at gjøre de forberedende Skridt til Anskaffelse af Apparater og Instrumenter.

Opmaalingsdirectionen foranstaltede derefter udstedt Indbydelse i de offentlige Blade saavel her i Riget som i Sverige til Anbud paa Bortleje af Fartoj. Der indkom Tilbud fra Rederierne for 11 Dampskibe, blandt hvilke

the same and superintend her equipment. The aforesaid authorities were unanimous in favour of the Expedition, and shared in the main the views set forth by the proposers in their Memorial.

The Department for Home Affairs agreeing with the Navy Department that the general management of the Expedition should devolve on the Directors of the Geographical Survey, the latter were desired, in a communication bearing date October the 15th, 1874, to prepare a statement of the probable outlay which such an Expedition would involve. On March the 8th, 1875, the Directors sent in their estimate, and on the 23rd of the same month His Majesty's Government brought the subject before the Privy Council in a formal proposition. The several declaratory statements from the above-mentioned authorities being to the effect, that it would be best to have a vessel built specially adapted for the Expedition, and the Directors of the Geograpical Survey having in their estimate also pronounced in favour of that alternative, it was advocated in the Government proposition, the Home Department most respectfully submitting, that application should be made to the Storthing for a grant of Spd. 61,500 (Kr. 246,000), to defray the cost of a fully equipped vessel, including instruments and preliminary expenses. This proposition was approved by an Order in Council, bearing date March the 30th, 1875.

On the 20th and 21st of May, the subject was deliberated in the Storthing, the issue of the debate being that a vessel should be chartered for the Expedition, the House declaring in favour of the following motion, brought forward by the representative Haugland: —

"For the purchase of instruments, apparatus, &c., and for defraying the current expenses of the first year's cruise of a Scientific Expedition to the tract of ocean stretching between Norway, the Færoe Islands, Iceland, Jan Mayen, and Spitzbergen, the Storthing doth hereby grant for the financial year commencing July the 1st, 1875, and terminating July the 1st, 1876, a sum not exceeding Spd. 20,000 (4,444 *l.*)

The State having accordingly resolved to despatch an Expedition, Captain *C. Wille*, R. N., who, as commander of the "Hansteen," a steamer built for the Norwegian coast survey, had been engaged in conducting deep-sea soundings off the coast, and who had assisted the Directors of the Geographical Survey when preparing their estimate of the cost of the Expedition, — was appointed by the Home Department to take the preparatory steps for fitting her out; and two days after the assent of the Storthing had been given, Capt. Wille left for England, partly that he might there confer with the captain of the "Challenger," G. S. Nares, who was shortly to set out on the British Polar Expedition, partly to arrange for the purchase of apparatus, instruments, &c.

Soon after Capt. Wille's departure, the Directors of the Geographical Survey invited ship-owners, both in this country and in Sweden, by advertisements in the public journals, to make offer of a vessel for the Expedition. The number

et svensk. Ved kongelig Resolution af 23de December 1875 blev Dampskibet "Vøringen" af Bergen antaget, da det ansaaes i det Hele hensigtsmæssigt og solid, da Rederiet strax havde gjort det billigste Tilbud og ligeledes gik ind paa de Fordringer, der stilledes angaaende Rig og Indredning.

Den af Departementet med Rederiet afsluttede Kontrakt, der i det væsentlige ligelydende fornyedes for hvert af de to følgende Aar 1877 og 1878 (med Undtagelse af at Lejen forhøjedes til 1,100 Spd. pr. Maaned) var saalydende:

"Rederiet bortforpagter herved Dampskibet "Vøringen" til Brug for Atlanterhavs-Expeditionen og leverer Skibet i Bergen omkring den 15de April, saafremt ikke Havari derfor er til Hinder. I dette Tilfælde skal Rederiet, saa snart ske kan, indsende Underretning til Departementet. Dersom Expeditionens Chef ikke anser det rimeligt, at Skibet vil kunne leveres senest de første Dage af Maj, er han berettiget til at anse nærværende Kontrakt som hævet. Skibet afleveres igjen i Slutningen af August eller Begyndelsen af September, saafremt intet uforudseet Tilfælde indtræffer.

Skibet leveres hægt og tæt, doksat, rengjort og malet, Maskinen efterseet og i fuld Orden, udstyret med Topsejl paa begge Master og dertil hørende Rig, samt forsynet med tilstrækkelig Ballast.

Rederiet tillader Skibets Indredning og Udbedring igjen efter endt Togt, overensstemmende med de af Hrr. Brunchorst & Dekke leverede Planer.

Det kongelige Departement vedtager at have befragtet "Vøringen" for ovennævnte Tidsrum paa ovennævnte Betingelser, samt at betale i Fragt 1000 Spd. pr. Maaned fra den Dag, Skibet afleveres til Indredningens Paabegyndelse, indtil det igjen tilbageleveres i Bergen i ryddiggjort og udbedret Stand. Maaneden regnes fra Dato til Dato og for overskydende Dage regnes 33 Spd. 40 Skill. pr. Dag. Betalingen erlægges ved hver Befragtningsmaaneds Udløb.

Skibet gaar for Rederiets Risico. Som Følge heraf ophører Lejen i Tilfælde af totalt Forlis eller af saadant Havari, hvis Reparation af Expeditionens Chef antages at ville medtage saa lang Tid, at Expeditionen ikke mere med Nytte kan fortsættes det Aar.

Ved totalt Forlis ophører Lejen strax. Er totalt Forlis ikke bevisligt, men Fartøjet udebliver, betales Lejen vedvarende, dog ikke længere end 10 Uger fra den Tid, da seneste Efterretninger indløb.

I Tilfælde af saadant Havari, som nævnt, har Expeditionens Chef, naar han kommer i Havn, derom at underrette Rederiet, med Opfordring til dette om ufortøvet at modtage Fartøjet. Leje betales i dette Tilfælde i en Maaned fra den Dag, Underretningen er givet, dog under

of tenders received was 11, one from Swedish owners. An Order in Council, bearing date December the 23rd, 1875, confirmed the selection of the steamship "Vøringen," of Bergen, a vessel strongly built, and, on the whole, well adapted for the requirements of the Expedition; moreover, her owners, whose offer was the lowest, had at once agreed to the stipulated conditions respecting equipment, &c.

The Contract between the Home Department and the owners of the "Vøringen," which, with the exception of a clause raising the hire to Spd. 1100 per month, was renewed in the same form for each of the following cruises (in 1877 and 1878), ran as follows: —

"The owners of the S. S. "Vøringen" do hereby agree to let that vessel for the use of the North-Atlantic Expedition, and undertake to deliver her in the port of Bergen on, or about, the 15th of April, unless she have sustained damage, in which case her owners shall forthwith send notice to the Home Department. Should the Naval Director of the Expedition feel convinced that the vessel cannot be got ready by the first week in May, he shall be at liberty to cancel this Contract. The vessel to be given up to the owners at the end of August, or the beginning of September, no unforseen event intervening.

"The vessel to be delivered in warrantable condition, docked, careened, and painted, with her engines examined and in perfect working order; moreover, she shall be rigged with a top-sail to each mast, and have sufficient ballast.

"The owners agree to the ship being fitted up and repaired at the end of the cruise conformably to the plans furnished by Messrs. Brunchorst and Dekke.

"The Home Department of His Majesty's Government doth hereby acknowledge to have chartered the S. S. "Vøringen" for the aforesaid term and on the aforesaid conditions, at the rate of Spd. 1000 per month, from the day on which the ship is delivered in Bergen to the deputed agent of the Government to the day on which she is given up, put in order and repaired, to the owners in Bergen. For every day over and above a full calender month shall be paid 33 Spd. 40 Skill. The freight to fall due at the expiration of each month of the term for which the vessel is chartered.

"The ship to sail at the owners' risk. Hence all payment of freight shall cease in the event of total loss, or of the vessel sustaining such damage that the repairs thereby entailed, in the opinion of the Naval Director of the Expedition, cannot be completed sufficiently soon to admit of continuing the cruise with advantage.

"Total loss cancels the contract at once. But should total loss not admit of proof, from the absence of the vessel, the freight shall continue to be paid, though not for longer than 10 weeks from the date at which intelligence of the vessel was last received.

"In the event of the ship sustaining damage as aforesaid, the Naval Director of the Expedition shall, on his arrival in port, communicate with the owners, desiring them to take charge of the vessel forthwith. In such case the liability for freight to extend one calender month from the

ingen Omstændigheder længere end til 7de September."

Ved kongelig Resolution af 5te Februar 1876 blev det overdraget følgende Videnskabsmænd at deltage i Expeditionen: Professor i Meteorologien *H. Mohn*, Professor i Zoologi *G. O. Sars*, Overlæge ved Lungegaardshospitalet i Bergen Dr. med. *D. C. Danielssen*, Kjøbmand i Bergen *Herman Friele* og Stud. real. *S. M. Svendsen*. Som Chef for Expeditionens Skib antoges ved samme Resolution Captein *C. Wille*, der tillige skulde overtage Udførelsen af de videnskabelige Iagttagelser, som vare forudsatte fremmede ved Expeditionen og som ikke specielt maatte gaa ind under nogen af de øvrige ved Expeditionen ansatte Videnskabsmænds Omraade. Som Tegner blev senere antaget Landskabsmaler *F. Schiertz*.

Efter Opmaalingsdirectionens Foranstaltning besørgede Capt. Wille Anskaffelsen af de til Expeditionen fornødne Instrumenter og Apparater samt Skibets Indredning og Udrustning.

For Expeditionens videnskabelige Medlemmer blev givet af Opmaalingsdirectionen følgende af Departementet for det Indre approberede Instrux, der var gjældende for hvert af de tre Aar 1876, 1877 og 1878.

§ 1.

Den for Expeditionen approberede Plan søges udført, saavidt Vejrforhold eller andre uforudseede Omstændigheder ikke er ivejen derfor. Afgjørelsen af hvorvidt Vejrforhold eller Skibets Tilstand maatte træde hindrende ivejen, tilligger Fartøjets Chef.

§ 2.

Planens Udførelse i det enkelte sker efter Samraad og Afstemning af Expeditionens videnskabelige Medlemmer, til hvilke ogsaa Fartøjets Chef hører.

Afgjørelsen sker efter simpel Pluralitet.

De videnskabelige Medlemmer vælge sig imellem en Formand, hvis Stemme i Tilfælde af Stemmelighed gjør Udslaget.

§ 3.

Skulde den under Rejsen gjorte Erfaring gjøre det sandsynligt, at Afvigelser fra den lagte Plan i højere Grad vilde ramme Expeditionens Formaal, kunne saadanne foretages, naar samtlige videnskabelige Medlemmer derom ere enige.

§ 4.

Chefen for Expeditionsskibet har at sørge for, at dette er hensigtsmæssigt udrustet og forsynet med de for Expeditionens Øjemed nødvendige Apparater, samt at de Rejser og Manøvrer blive udførte, der udfordres til Opnaaelse af Expeditionens Formaal.

§ 5.

Naar Havn anløbes meddeler Skibschefen Bestyrelsen fornøden Underretning om Expeditionens Fremgang, ligesom han ogsaa aflægger samlet Rapport efter endt Togt. Efter Expeditionens Afslutning indsendes fra dens viden-

day on which the intelligence was received, but not longer than the 7th of September."

By an Order in Council, bearing date February the 5th, 1876, the following gentlemen were appointed members of the Scientific Staff: — *H. Mohn*, Professor of Meteorology; *G. O. Sars*, Professor of Zoology; *D. C. Danielssen*, M. D., physician to Lungegaard's Hospital in Bergen; *Herman Friele Esq.*, merchant in the city of Bergen; and *S. M. Svendsen*, undergraduate of the University of Christiania. By the same Order, Capt. *C. Wille*, R. N., was appointed to command the vessel chartered for the Expedition, and to institute such scientific observations as there would, it was believed, be found facilities for taking, but which did not strictly come within the province of any member of the Civilian Scientific Staff. Subsequently, the services of *F. Schiertz*, artist, were also engaged.

At the instance of the Directors of the Geographical Survey, Capt. Wille procured for the Expedition the necessary instruments and apparatus, and superintended the general fitting-out of the vessel.

For the guidance of the Scientific Staff on board, the Directors of the Geographical Survey, with the sanction of the Home Department, issued the following Instructions, which remained in force on the three cruises of the Expedition, in 1876, 1877, and 1878.

§ 1.

The Scheme approved for the Expedition shall be strictly adhered to, unless bad weather, or some unforseen interfering cause, prevent its being carried out. It rests with the Captain to pronounce on the state of the weather and of the ship.

§ 2.

Previous to execution, all the details of the Scheme shall be discussed and put to the vote by the Scientific Staff on board, of which the Captain of the vessel is a member.

The decision of the majority to be final.

The Scientific Staff shall from among their number elect a chairman, who has the casting vote.

§ 3.

If, during the progress of the cruise, very considerable deviation from the Scheme approved for the Expedition be found advisable, such deviation is permitted, all the members of the Scientific Staff consenting thereto.

§ 4.

On the Captain of the vessel shall devolve the duty of fitting her out, and of furnishing her with the necessary apparatus, as also of navigating and working her in a manner calculated to attain the object of the Expedition.

§ 5.

From every port at which the vessel may touch, the Captain shall advise the Directors of the Geographical Survey of the progress of the Expedition: and after his return he has to report generally on the cruise. The Expedition

skabelige Medlemmer en Generalberetning til Bestyrelsen.

§ 6.

De Samlinger af videnskabelige Iagttagelser og Naturalier, som Expeditionen tilvejebringer, forblive denne tilhørende, indtil de efter Bestemmelse af Expeditionens videnskabelige Medlemmer ere bearbejdede. Publikationen af de gjorte Iagttagelser samt deres Resultater og Fordelingen af de indsamlede Naturalier bestemmes af Bestyrelsen efter Forslag af de videnskabelige Medlemmer.

For hvert Aars Togt udarbejdedes af Expeditionens Medlemmer i Forbindelse med Opmaalingsdirectionen (General Grimsgaard, Fyrdirektør Diriks og Professor Mohn) en Arbejdsplan, der indsendtes til Departementet for det Indre til Approbation.

1876.

Den for dette Aar approberede Plan var følgende:

Saasnart Expeditionsfartøjet i Bergen har modtaget sin fulde Udrustning og de Instrumenter og Apparater, der skulle have sin Plads ombord, ere anbragte, kunne de Iagttagelser begynde, der ere nødvendige for Bestemmelsen af de forskjellige magnetiske Constanter ved Skibet og de respective Instrumenter.

Da saadanne Iagttagelser bør foretages paa et Sted, der er saavidt muligt frit for den saakaldte magnetiske Localattraction, og da Erfaringen fra "Hansteens" Togt i 1875 har vist, at man ikke kan gjøre Regning paa at blive fri for denne Virkning, førend man kommer ud paa de yderste Øer og Skjær paa Kysten, ville de nævnte Iagttagelser ikke kunne udføres med Fordel i Bergen.

Af Resultaterne af "Hansteens" Togt i 1875 fremgaar det, at Øerne Utvær, og navnlig Huso ved Sognefjordens Munding har den forønskede Frihed for Localattraction. Paa dette Sted ville derfor de forberedende magnetiske Iagttagelser antagelig bedst blive at udføre. Hvor lang Tid disse Iagttagelser ville tage, beror paa Vejrforholdene, navnlig fordi der til enkelte af dem kræves Sol til en bestemt Dagstid.

Da en Flerhed af de Instrumenter og Apparater, hvormed Expeditionen vil have at arbejde, paa denne komme til Anvendelse under Forhold, der paa Grund af Foretagendets større Maalestok og Udrustningens større Fuldstændighed ere Expeditionens Deltagere delvis nye, og da Mandskabet trænger til Opøvelse i de for de videnskabelige Operationer nødvendige Manøvrer, ansees det for mest hensigtsmæssigt og i Længden mest tidsbesparende at foretage foreløbige Forsøg til Øvelse med samtlige de under Expeditionen benyttende Apparater.

En udmerket Lejlighed til den første Prøve, der tillader Operationerne at foregaa i smult Vand paa samme

ended, the members of the Scientific Staff shall send in a General Report to the Managing Committee.

§ 6.

The observations instituted and natural objects collected shall belong to the Expedition till such time as, with the approbation of the Scientific Staff, they have been duly worked out and described. The publication of the observations and their results, and the distribution of the natural objects, to devolve on the Directors of the Geographical Survey, and to be in accordance with the proposition of the Scientific Staff.

For each cruise the members of the Scientific Staff, in conjunction with the Directors of the Geographical Survey (General Grimsgaard, F. Diriks, Director of Lighthouses, and Professor Mohn), drew up a Scheme of Work, which was laid before the Home Department for approval.

1876.

The Scheme approved for this year was as follows: —

When the vessel selected for the Expedition, now lying in the port of Bergen, has been fully equipped, and the instruments and apparatus with which she is to be furnished have been arranged on board, the observations necessary to determine the magnetic constants for the ship and the respective instruments may forthwith commence.

As such observations should be taken in a spot as nearly as possible free from the so-called magnetic local attraction, and the cruise of the "Hansteen" in 1875 having shown that this disturbing influence does not cease to be felt at a less distance from the coast than the outermost islands and skerries, the said observations cannot give satisfactory results if made in Bergen.

From observations instituted on the cruise of the "Hansteen" in 1875, it appears that the islands of Utvær, and more especially the island of Husø at the entrance to the Sognefjord, are well nigh uninfluenced by local attraction. On the latter island, therefore, it will be best to undertake the preliminary magnetic observations. What time will be required to complete these observations, must depend on the state of the weather, particularly since sunshine at a certain hour of the day is indispensable for some of them.

As very many of the instruments and appliances necessary for the Expedition, will have to be used under conditions which, by reason of the comparatively extensive scale whereon the Expedition has been planned, and the relative completeness of equipment, are in several respects new to the members of the Expedition; and the crew needing practice for the work connected with the scientific operations, it is deemed advisable, and will in the long run be the surest means of saving time, to make preliminary excursions, or trial-trips, with a view to acquire experience in handling the apparatus.

An excellent locality to begin with, that would admit of carrying on the operations both in smooth water and

Tid som den Dybde, paa hvilken der kan opereres, er betydelig, frembyder Sognefjorden, der i sin ydre Del, udenfor Ladvik, er over 660 Favne dyb.

Til Udførelsen af den Plan, i denne Del af Sognefjorden at foretage de første forløbige Arbejder, knytter sig den Interesse, som Undersøgelsen af Forholdene i Sognefjorden har, navnlig i zoologisk Henseende, i hvilken Retning Fjorden endnu er meget lidet undersøgt. Som bekjendt danner Sognefjorden ved sin ringe Dybde i Mundingen et fra Havet temmelig afsluttet Dybbassin.

Da der mellem det paapegede Punkt af Sognefjorden og Utvær kun er liden Afstand, vil man, naar Vejrforholdene falde ugunstige for de magnetiske Observationer paa dette Sted, med Lethed kunne benytte Tiden til Øvelserne i Sognefjorden og saaledes kunne gjøre Regning paa at faa begge disse forberedende Arbejder udførte i en rimelig Tid.

Efterat man saaledes har vundet det fornødne Kjendskab til Apparaterne og Øvelse i Brugen af dem i smult Vand, kræves, at man vinder Erfaring i deres Anvendelse paa Søen, i mindre roligt Vejr. De hertil fornødne Øvelser antages at kunne, paa den mest frugtbringende Maade, forenes med Udførelsen af Expeditionens egentlige Øjemed, ved følgende Ordning af Arbejdet.

Den dybe Rende, der ligger udenfor den norske Kyst fra Skagerak til Stat, fjerner sig her fra Kysten og synes at udmunde i Ishavsdybet. Der foreligger imidlertid Temperaturiagttagelser, der tyde hen paa Muligheden af, at Renden grunder op eller lukker sig. Undersøgelsen af dette Punkt vil derfor udgjøre en passende Gjenstand for Expeditionens Begyndelsesarbejder. Ved at følge Rendens Bund fra Sognefjorden af nordover og undersøge dens Forhold udenfor Stat og Romsdalskysten har man Fordelen af at være paa Søen i et Farvand, hvor Naturforholdene tilstede Apparaternes Anvendelse i forskjellige Retninger og hvor Undersøgelsernes Resultater ville blive baade instructive for Iagttagerne og oplysende for Videnskaben, og hvor man ikke er længere fra Land, end at man med Lethed vil kunne søge dette, for at iverksætte mulige Udbedringer eller ønskelige Forbedringer af Apparaterne, som Erfaring maatte vise det hensigtsmæssigt at foretage, førend man tiltræder Rejsen til fjernere Egne.

Efterat man saaledes havde vundet Erfaring i Søen og faaet undersøgt det Parti af de norske Kystbanker, hvorpaa Expeditionens videre Undersøgelser maa støtte sig, maatte man, forat komplettere Udrustningen for et længere Togt, anløbe en større Havn, t. Ex. Kristiansund. Her skulde Fartøjet blive at forsyne med komplet Udrustning af Kul og Vand, Kronometernes Stand og Gang bestemmes og mulige Udbedringer ved Apparaterne foretages.

Naar Expeditionen saaledes er i fuldt udrustet Stand (antagelig omkring St. Hanstider), kunne dens Arbejder

at a considerable depth, is the Sognefjord, which in its outer part, off Ladvik, is 660 fathoms deep.

Moreover, the selection of the Sognefjord as the tract wherein to commence the preliminary work of the Expedition, would afford a desirable opportunity of scientifically exploring that region, which has hitherto been but little investigated, in particular as regards its fauna. The Sognefjord constitutes, by reason of remarkable shallowness at its mouth, a deep basin well nigh cut off from the ocean without.

The distance between the above-mentioned point of the Sognefjord and Utvær being comparatively short, when the weather did not admit of continuing the magnetic observations in the latter locality, the time might be advantageously employed in the Sognefjord, and there would thus be a fair prospect of completing both parts of the preliminary work within a reasonable period.

Knowledge of the apparatus, and the requisite familiarity with their use in smooth water, having been thus attained, the next step will be to acquire experience of their application at sea in comparatively rough weather. The practice necessary for this purpose may, it is believed, be easily combined with the main object of the Expedition by conducting the work as follows: —

The deep channel extending along the shores of Norway from the Skagerak to Stat, leaves the coast in this locality, and would appear to disembogue into the depths of the Arctic Ocean. Perhaps, however, inferring from certain temperature-observations, the channel gradually shoals or closes. The clearing up of this question will form a fitting subject for the opening work of the Expedition. By following the channel from the Sognefjord northwards, and investigating its conditions off Stat and the coast of Romsdalen, the Expedition will secure the advantage of cruising in a tract of ocean which admits of a manifold use of the apparatus, and where the results of the investigation must prove alike instructive to the observers themselves and specially promotive of the interests of science; moreover, the distance from land being comparatively short, it will, if necessary, be easy to run in shore, for the purpose of repairing the apparatus, in case of accident, or of effecting such alterations in their construction as may be found desirable, before proceeding to more distant regions.

Having thus acquired experience in the use of the apparatus at sea, and investigated that portion of the Norwegian coastal banks on which the Expedition must base its subsequent operations, it will be necessary to touch at one of the larger ports, for instance Christiansund, and there complete the equipment of the vessel, — viz. by taking in a full supply of coal and water, examining the chronometers, repairing, if damaged, the apparatus, and effecting any improvements in their construction that experience may suggest.

Then, — so soon as the vessel shall in such wise have been fully equipped for the cruise (about the end of June), the work

fortsættes med Afslutningen af Undersøgelserne af Bankerne udenfor Romdalskysten henimod Shetland.

Fra dette Felt kommer man videre vestover til den dybe Rende mellem Shetland og Færøerne, der, navnlig i dens sydvestre Del, har været Gjenstand for "Porcupine"-Expeditionens Undersøgelser. Dens nordøstre Del vil det blive den norske Expeditions Opgave at undersøge nærmere og studere dens Overgang til det kolde Ishavsdyb. Paa denne Strækning ville Iagttagelser af Strømforholdene samt Undersøgelse af Havvandets Beskaffenhed i de forskjellige Dybder, til hvilke Forholds Undersøgelse den norske Expedition antagelig vil være bedre udrustet end den nævnte Britiske, kunne blive af fundamental Betydning for Havstrømmenes Theori.

En Betingelse for Held er imidlertid roligt Vejr.

Efter Afslutningen af Undersøgelsen af Færø-Shetland Renden, vil det af flere Grunde, der nedenfor ere nævnte, være hensigtsmæssigt, at man anløber Thorshavn paa Færøerne, for at forberede sig til Undersøgelsen af Strækningen mellem Færøerne og Island.

Undersøgelserne paa denne Strækning ville omfatte Forholdene ved Overgangen fra det forholdsvis grunde Hav mellem Færøerne og Island, der endnu tilhører Atlanterhavet, til det kolde Ishavsdyb, der ligger østenfor. Her kommer Expeditionen til at arbejde paa et saagodtsom i alle Henseender aldeles nyt Felt, hvad der ogsaa gjælder de følgende Strækninger.

Paa Island er det nødvendigt at foretage lignende magnetiske Iagttagelser som dem, der ere tænkte udførte paa Utvær. Antagelig vil Reykjaviks Havn i denne Henseende frembyde en bekvem Lejlighed.

Mellem Kap Farvel og Island er der i sidste Sommer af Chefen for den britiske Fregat "Valorous," Captein Jones, udført en Række Iagttagelser af Dybtemperatur i Forbindelse med Bundskrabninger. Denne Række udfylder paa en efter Omstændighederne tilfredsstillende Maade Overgangen mellem de tidligere undersøgte Dele af Atlanterhavet og den Linie, der — som dannende Overgangen fra Atlanterhavet til vort arktiske Havbassin — maa blive at sætte som den vestlige Grændse for den norske Expeditions Undersøgelsesfelt, nemlig Linien gjennem de Stræder og Havstrækninger, der adskille Shetlandsøerne, Færøerne, Island og Grønland.

For at fuldstændiggjøre Undersøgelserne paa denne Linie bliver det den norske Expeditions Opgave at forsøge undersøgt Strækningen mellem Island og Grønland, en Opgave, hvis Løsnings Vigtighed Dr. Carpenter, en af Deltagerne og Lederne af flere af de britiske Dybhavsexpeditioner, med Styrke har gjort opmerksom paa.

of the Expedition can be continued, by closing the investigation of the banks off the coast of Romsdalen in the direction of the Shetland Islands.

Westwards from this tract extends the deep channel between the Shetlands and the Færoe Islands, which — in particular its south-westerly portion — was explored on the "Porcupine" Expedition. The north-eastern part, together with the how and where this channel passes into the depths of the Arctic Ocean, will be made a subject of special investigation by the Norwegian Expedition. Observations on the direction and rate of the currents throughout this section of the channel, and on the chemical constituents of the water at different depths, which the Norwegian Expedition, from the character of its equipment, will, it is believed, have greater facilities for instituting than had the above-mentioned British Expedition with the "Porcupine," may prove of fundamental importance in elucidating the theory of ocean currents.

Meanwhile, a *sine quâ non* for achieving success is favourable weather.

After terminating the investigation of the Færoe-Shetland channel, it will, for divers reasons, specified below, be advisable to touch at Thorshavn on the Færoe Islands, previous to exploring the ocean-tract between the Færoe Islands and Iceland.

In this locality, the Expedition will investigate the nature of the transition from the comparatively shallow sea (part of the Atlantic) between the Færoe Islands and Iceland to the depths of the Arctic Ocean, stretching eastwards. Here, the exploratory work will be in a field essentially new, which also applies to the succeeding tracts.

In Iceland, magnetical observations must be instituted similar to those the Expedition will take at Utvær. For this purpose, the port of Reykjavik is believed to be a convenient locality.

Last summer a series of deep-sea temperatures, in connexion with dredgings, were taken by Loftus Jones, captain of the British frigate "Valorous," between Cape Farewell and Ireland. These observations have, as far as circumstances would permit, contributed greatly to our knowledge of the part of the Ocean lying between the sections of the Atlantic previously investigated and the line which — constituting as it does the boundary between the Atlantic and the basin of the Arctic Ocean — must be regarded as the western limit of the region it is the object of the Norwegian Expedition to explore, viz. the line passing through the straits and tracts of ocean that extend between the Shetlands, the Færoe Islands, Iceland, and Greenland.

With a view to render the investigation along this boundary-line as complete as possible, the Norwegian Expedition will endeavour to explore the tract between Iceland and Greenland, — a problem to the importance of which Dr. Carpenter, member and co-director of several of the British deep-sea Expeditions, has repeatedly drawn attention.

Det er ikke sandsynligt, at Isforholdene skulde lægge den norske Expedition Hindringer ivejen for Udførelsen af denne Undersøgelse, og heller ikke for dens Fortsættelse paa Strøget nordenom Island. Ved at denne Vej følges, banes en vigtig Overgang til det egentlige Ishavsdyb, som dernæst maatte blive at gjennemskjære med et Snit fra et Punkt i nordost for Island til et Punkt paa Norges Kyst nordenfor Trondhjem. Paa denne sidste Del af Rejsen ville sandsynligvis alle Ishavsdybets vigtigste Naturforhold komme tilsyne i Iagttagelserne.

Med gunstige Vejrforhold vil den ovennævnte Del af Expeditionens Plan muligens kunne blive udført i en saavidt kort Tid, at der efter Tilbagekomsten til Norge endnu bliver Anledning til videre Undersøgelser. Om disse da bør rettes paa en Linie tvers over Ishavet mod Jan Mayen eller paa Overgangen mellem Bankerne foran Nordlands Kyst og Ishavsdybet, vil bedst den indtil da vundne Erfaring og Hensyn til den tilbagestaaende Arbejdstid kunne afgjøre.

That the Expedition will meet with impediments from ice, either in this region or in the tract north of Iceland, there is little reason to apprehend. This course will lead by a direct transit-passage to the depths of the Arctic Ocean, which have then to be traversed from a point north-east of Iceland to a point on the Norwegian coast north of Throndhjem. The observations taken on this, the latter part of the passage, will in all probability disclose the most important of the conditions distinguishing the depths of the Arctic Ocean.

Provided the weather be favourable, the Expedition will possibly get through this part of the Scheme and return to Norway in time for further operations. Whether, in that case, it will be best to conduct the investigation along a line traversing the Polar Sea in the direction of Jan Mayen, or in the tract extending between the banks off the coast of Nordland and the depths of the Arctic Ocean, must depend on the nature of the experience till then acquired, and on the time that may yet remain available for continuing the cruise.

Bestyreren af det danske meteorologiske Institut, der har Stationer i Torshavn paa Færøerne, og paa Island i Berufjord og Papey paa Sydostsiden, i Reykjavik og Stykkisholm paa Vestsiden samt i Akureyri og paa Grimsey paa Nordsiden, har anmodet Bestyreren af det norske meteorologiske Institut om under Expeditionen at inspicere de af disse Stationer, hvortil der maatte blive Anledning. Da de nævnte Stationer ere erkjendte for at være af fundamental Betydning for hele Europas og ikke mindst for Norges Meteorologi, vil Expeditionen kunne yde denne Videnskab, hvis Fremme ligger indenfor dens Arbejders Kreds, en ganske væsentlig Tjeneste ved at imodekomme det af det danske Instituts Bestyrer fremsatte Ønske. Stationerne ligge lige i den Vej, som Expeditionsskibet efter denne Plan vil komme til at følge og ville afgive de mest passende Stoppepladse til Indtagelse af Forsyninger, til Verification af Kronometrene og de magnetiske Instrumenter, til Udførelse af Arbejder ombord, der kræve hurtigere Fremme og vanskelig kunne udføres i Søen, til Undersøgelse af Naturforholdene paa Kysten, til Tilflugtssteder under Vejrforhold, der umuliggjøre Arbejde i Søen m. v.

The Director of the Danish Meteorological Institute, which has Stations on the Færoe Islands (Thorshavn) and in Iceland (south-east coast: Berufjord and Papey; west coast: Reykjavik and Stykkisholm; north coast: Akureyri and Grimsey), deems it highly desirable that the Director of the Norwegian Meteorological Institute should inspect such of those Stations as the Expedition may furnish opportunity of visiting. Now, the said Stations are acknowledged to be of fundamental importance to the meteorology of Europe, — and not least to that of Norway, — wherefore the Expedition could very materially promote that science by acceding to the request preferred by the Director of the Danish Institute to the Director of the Norwegian. Moreover, the Stations lie one and all in the route the Expedition will take pursuant to the Scheme of Work; they are excellently adapted for stopping-places, at which to provision the ship, verify the chronometers and the magnetic instruments, do work on board that does not admit of delay, or can with difficulty be accomplished at sea, investigate physical and other conditions on the coast, &c. &c.: and finally, they would serve as harbours in stress of weather, when all work at sea was impracticable.

De Undersøgelser, der ville blive Gjenstand for Expeditionens Arbejder, ere i det væsentlige følgende:

1. *Lodninger* til Bestemmelse af Havbundens Configuration. Under disse komme Samling af Prøver af Bundens Materiale samt flere af de Operationer, der tjene til Grundlag for de nedenfor nævnte Undersøgelser.
2. Bestemmelse af *Strømmens* Retning og Hastighed. Overfladestrømmens Retning og Hastighed søges be-

The following is a General Specification of the objects which the Expedition will seek to carry out: —

1. To determine by *soundings* the contour of the sea-bed. When taking them, samples of the bottom will be simultaneously collected, and divers of the operations performed necessary to serve as a basis for the work specified below.
2. To determine the direction and rate of *currents*. The direction and rate of surface-currents will be

stemt dels ved hvert Lodskud, dels ved de sædvanlige nautiske Methoder. Undersøgelsen af Strømmen i Dybet vil udkræve særskilte Methoder og kun lade sig udføre under gunstige Omstændigheder. Disse sidste Undersøgelser maa i Regelen forbeholdes enkelte Punkter, hvor de ere af fundamental Betydning, som Færø-Shetland-Renden, Færø-Island-Flakket, Island-Grønland-Strædet og det kolde Ishavsdyb samt Norges Banker.

3. Bestemmelse af *Havets Temperatur* i Overfladen falder nærmest ind under de meteorologiske Iagttagelser. Dybets Temperatur ved Bunden bestemmes ved hvert Lodskud. Under gunstige Omstændigheder og paa saa mange Punkter, det maa ansees at være af Interesse, tages Rækker af Temperaturiagttagelser i forskjellige Dybder fra Overfladen til Bunden med de forskjellige Instrumenter, som Expeditionen hertil disponerer over.

4. Undersøgelse af *Havvandets fysiske* og *chemiske* Forhold: Specifisk-Vægt-Bestemmelse med Areometer, Saltholdighed (Chlormængde) ved Titrering, Luftmængde og Kulsyremængde ved Udkogning. De yderlig fornødne Analyser af de opsamlede Gasarter samt af større Prøver af Havvand, som medtages fra Steder, hvor Forholdene ere typiske, maa udføres i Laboratoriet efter Expeditionens Slutning. Ved de fleste Lodskud tages Vandprøver fra Havbunden til Bestemmelse af specifisk Vægt og Saltholdighed. Paa særegne Steder tages en Række Prøver af Vand fra forskjellige Dybder til Undersøgelse i forskjellige Retninger, dels ombord, dels senere.

5. *Zoologiske* Undersøgelser. Indsamling af Havdyr med de dertil bestemte Apparater, deres foreløbige Undersøgelse og Gruppering, deres Præparation og Opbevaring. Indsamling af Specimina af Dyreriget forøvrigt efter Lejligheden. Ved de for disse Undersøgelser nødvendige Operationer vindes ogsaa Prøver af Havbundens Materiale til Opbevaring.

6. *Botaniske* Undersøgelser: Indsamling af Specimina af Planteriget, deres Præparation og Opbevaring til videre Undersøgelse.

7. *Meteorologiske* Iagttagelser. Stadig fortsatte Iagttagelser af Barometer, Psychrometer, Vindens Retning, Styrke og Hastighed, Skyernes Mængde, Form og Bevægelse, Søgang, Nedbør m. m. Forsøg med Hygrometer til Control for Psychrometret, med Regnmaaler og Fordunstningsmaaler, med Thermometre paa forskjellige Steder og i forskjellige Højder. Maaling af Havvandets Temperatur og specifiske Vægt i Overfladen.

determined partly by the operation of sounding, and partly by the usual nautical methods. For investigating deep-sea currents, recourse must be had to special methods, practicable only under favourable circumstances. Such investigations must therefore, as a rule, be confined to a few localities in which they will be of fundamental importance, viz. the Færoe-Shetland channel, the Færoe-Iceland flat, the channel between Iceland and Greenland, the cold area of the Arctic Ocean, and the banks off the coast of Norway.

3. To determine the *Surface-temperature of the Sea*, which comes strictly within the meteorological observations. The bottom-temperature will be determined with every sounding. Under favourable circumstances, serial temperature observations will be taken, in as many localities as may be deemed desirable, at different depths, from the surface to the bottom, with the various instruments provided for the purpose.

4. To investigate the *Physical Conditions* and *Chemical Constituents* of the sea-water. This will comprise: specific gravity determinations with the areometer; salt-determinations (amount of chlorine) by titration; air and carbonic acid determinations by the boiling-process. All further analyses of gases collected on the Expedition, as also of large samples of sea-water from localities characterised by typical conditions, must be made in the Laboratory after the return of the Expedition to Norway. When soundings are taken, samples of bottom-water will be generally collected, for determining the specific gravity and the amount of salt. At certain stations, samples of water will be collected from different depths, for examination either on board or at a subsequent date.

5. *Zoological* Work, comprising the collection of marine animals, with the apparatus provided for the purpose, their preliminary examination and classification, preparing and preserving them on board, and the occasional collection of other specimens of the animal kingdom. When conducting the operations for capturing marine animals, samples of the bottom will also be collected.

6. *Botanical* Work, comprising the collection of specimens of the vegetable kingdom, and preserving them for subsequent examination.

7. *Meteorological* Observations, comprising regular readings of the barometer and psychrometer; observations of the force, direction, and velocity of the wind, the form, amount, and motion of clouds, the state of the sea, precipitation, &c., &c.; experiments with the hygrometer, to control the psychrometer, with the rain-guage, and with thermometers in different localities and at different heights above the level of the sea; determinations of the temperature of the sea and of the specific gravity of the water at the surface.

8. *Magnetiske* Iagttagelser. Daglige — om Vejret tillader det — Bestemmelser af Misvisningen, Inclination og Intensitet. Observationernes Beregning saavidt ske kan. Observationer paa Land- (Basis-)Stationer til Bestemmelse af de nodvendige magnetiske Konstanter.
9. Lejlighedsvise Iagttagelser, hvortil Tid og Sted maatte give Anledning, saasom hydrografiske Undersogelser, astronomisk-geografiske Stedbestemmelser, geologiske Iagttagelser m. m.

8. *Magnetical* Observations (taken daily, weather permitting), to determine declination, inclination, and intensity, so far as practicable, with computation of the results. For determining the magnetic constants, observations will be instituted on shore, at base-stations.
9. Occasional observations, for which time and place may furnish opportunity, such as hydrographical observations, observations of latitude and longitude, geological observations, &c. &c.

Den 14de April blev Dampskibet "Voringen" i Bergen overtaget for Expeditionens Regning, og det overdroges D'Hrr. Brunchorst & Dekke at udføre Forandringerne og Indredningsarbejderne efter den vedtagne Plan. Mod Slutningen af Maj Maaned var disse færdige og samtlige Apparater saavidt muligt paa Plads, hvorefter Expeditionens Deltagere, Professorerne Mohn og Sars, Dr. Danielssen, Hrr. Friele, Hrr. Svendsen og Landskabsmaler Schiertz embarkerede. Som Skibsofficerer var antagne Premierlieutnant i Marinen *R. M. Petersen* og Skibsfører *J. Grieg*.

On the 14th of April the S.S. "Voringen," lying in the port of Bergen, was taken in charge for the Expedition, and Messrs. Brunchorst & Dekke commissioned to undertake the necessary alterations &c., in conformity with the approved plan. By the latter end of May the vessel was ready for sea; and all instruments and apparatus having been got on board, and so far as possible arranged, the several members of the Expedition, — Professors Mohn and Sars, Dr. Danielssen, Mr. Friele, Mr. Svendsen, and an artist, Mr. Schiertz, forthwith embarked. The chief officers (exclusive of the captain) were — *R. M. Petersen*, R.N., first lieutenant; *J. Grieg*, merchant-captain.

Om Morgenen den 1ste Juni afgik Expeditionen fra Bergen og sejlede ind i Sognefjorden, hvor den samme Dags Eftermiddag ankrede i Esefjord. Efter nogle Forberedelser foretoges i Fjorden udenfor Esefjord de første Lodninger og Skrabninger til Prove. Lodningen foregik strax uden Vanskelighed. Ved den første Skrabning havde vi det Uheld, at Skrabetouget sprang, uden synderlig paagaaende Kraft, paa Grund af en Fejl i Sammenslagningen, hvilket var saameget mere uheldigt, som det vakte Tvivl om Tougverkets Godhed. Dette viste sig imidlertid senere udmærket, og den første var den eneste Skrabe, der paa hele Expeditionen gik tabt af denne Aarsag. Den næste Skrabning var ogsaa uden Resultat, da Farten havde været for stor, hvorved Skraben strax løftedes fra Bunden, men hermed var ogsaa den fornødne Erfaring indvunden med Hensyn til denne Manøvre.

On the morning of the 1st of June the Expedition left Bergen, steaming northward for the Sognefjord, which it reached on the afternoon of that day, and cast anchor in the Esefjord, an arm of the above. After a few preparations, the first soundings and dredgings were commenced, off the mouth of the Esefjord. No difficulty whatever attended the former operation: but at the first trial with the dredge, the rope, though not exposed to any considerable strain, unfortunately parted, owing to some defect in the manufacture; which was the more to be regretted, since it gave reason to apprehend that the general quality of the rope-work supplied to the Expedition might prove inferior. Happily, however, it turned out to be excellent, and no other dredge was lost in this manner. The next dredging also proved unsuccessful, from the speed of the vessel, which was too great, causing the dredge to be lifted off the bottom. Meanwhile, sufficient experience had been acquired in the use of the apparatus.

Anden Pintsedag, den 5te Juni, foretoges en Excursion til Bojum-Bræen i Fjærland. Forøvrigt anvendtes Tiden med Klargjøring af Lodde- og Skrabe-Apparaterne og med deres Anvendelse paa Dybet. Den 8de Juni gik vi udover Sognefjorden, tog nogle Lodskud udenfor Bofjorden, hvor Dybden endnu var 600 Favne og ankrede om Aftenen paa nævnte Sted. Den 9de om Morgenen bestemtes

On Whit Monday, the 5th of June, an excursion was made to the Bojum glacier, in Fjærland. The following days were occupied with getting in order the sounding and dredging apparatus, and working them in deep water. On the 8th of June we steamed out of the Sognefjord, took a few soundings off the Bofjord, where the depth was still found to be not less than 600 fathoms, and in the

Bundens Opgang fra det store Dyb inde i Sognefjorden til dennes ydre grundere Del og toges et Par Skraber i denne sidste, hvorpaa Expeditionen gik ud til Husø ved Fjordens Munding. Her blev den liggende i 10 Dage, der anvendtes til magnetiske Observationer i Land og til Svingning af Skibet for at bestemme de magnetiske Constanter for Navigationen og for de magnetiske Instrumenter ombord. Til samme Tid toges daglig Skrabninger fra Baad af Zoologerne.

Den 20de Juni gik Expeditionen tilsos. Vejret, der under Opholdet i Husø havde været noget uroligt blev efterhaanden udmærket. Overensstemmende med Planen begyndte man strax med Bestemmelsen af den langs Kysten løbende dybe Rendes Affald mod Ishavet. Under dette Arbejde fik vi første Gang iskoldt Vand i Dybet om Aftenen den 21de Juni paa 62° 45′ N. Br. og 1° 48′ L. Ø. f. Gr. og ved Skrabningen sammesteds den første *Umbellularia*. Til Middag den 23de arbejdedes Dag og Nat med Lodninger, Skrabninger, Temperaturrækker og Optagning af Vandprøver fra Bund og Overflade. Skibets Vej og de Stationer, hvor der er foretaget Undersogelser, er afsatte paa det medfølgende Oversigtskart.

Fredag den 23de Juni ankom Vøringen til Kristiansund. Den 24de og 26de anvendtes til at fylde Kul og Vand samt gjøre nogle mindre Anskaffelser. Mandskabet blev forøget med 3 Mand, da Zoologerne tiltrængte mere Assistance end paaregnet, ligesom Arbejdet med Apparaterne viste sig mere anstrængende for Folkene, end man havde tænkt sig.

Tirsdag den 27de Juni afgik Expeditionen atter fra Kristiansund, og ud paa Storeggen, hvor der toges 10 Lodskud og 5 Bundskrabninger, hvorpaa Kursen sattes videre vestover. Den 30te Juni loddedes, trawledes og skrabedes i 525 (eng.) Favne og den 1ste Juli i 587 Favne paa 63° 5′ N. Br., 0° 53′ L. Ø. f. Gr. Lige siden Afgangen fra Husø havde Vejret været særdeles smukt, men den 1ste Juli begyndte den første Storm, og siden holdt Vejret sig usædvanligt ugunstigt lige til den 15de August.[1] Kl. 10 om Aftenen den 1ste Juli var Vindens Hastighed 20 Meter i Sekundet, Vindens Retning SSØ. og Fartøjets Kurs ØSØ, begge retvisende. Bølgernes Højde maaltes til 5—6 Meter. Da Vinden efterhaanden gik om paa SV., lagdes Kursen om Eftermiddagen den 2den Juli mod Vest. Vinden var svagere, men Søgangen hindrede fremdeles vore Arbejder paa Dybet. Den 3die Juli avancerede vi fremdeles langsomt vestover, men uden at kunne bruge Dybhavsapparaterne. Vinden var noget mindre stærk, men Søen fremdeles urolig, Bølgehøjden 3 Meter. Den 4de Juli om Morgenen

[1] Man se "Cartes synoptiques journalières, construites par N. Hoffmeyer, directeur de l'institut météorologique Danois," i hvilke vor Expeditions meteorologiske Iagttagelser er benyttede.

evening ran in shore to anchor. On the morning of the 9th was determined the rise of the bottom from the great inner depths of the Sognefjord to its shallower outer part, where we took one or two hauls of the dredge, and then proceeded on to Husø, at the mouth of the fjord. Here the Expedition remained 10 days, with the object of instituting magnetical observations on shore, and of swinging ship for deviation and determining the constants of the magnetical instruments. During our stay the zoologists dredged the bottom daily from a boat.

On the 20th of June the Expedition put to sea. The weather, which had been somewhat blustering at Husø, now began to moderate, and turned out remarkably fine. Agreeably to the approved plan, we at once proceeded to investigate the deep channel that stretches along the coast, and to explore its slope towards the basin of the Arctic Ocean. Whilst thus engaged, we struck in the depths, for the first time, water of 0° temperature, on the evening of the 21st, lat. 62° 45′ N., long. 1° 48′ E., and a haul of the dredge brought up our first specimen of *Umbellularia*. Till noon of the 23rd, our time was fully occupied with sounding, dredging, taking serial temperatures, and collecting samples of sea-water from the bottom and from the surface. The accompanying Plate shows the track of the ship and the Stations at which any exploring work was done.

On Friday the 23rd of June the "Vøringen" reached Christiansund. Two days — the 24th and the 26th — were passed in taking in coal and water, and otherwise completing the equipment of the vessel. At this port 3 additional hands were shipped, the zoologists needing increased assistance; the working the apparatus ship, too, had proved more laborious than originally anticipated.

On Tuesday the 27th of June the Expedition left Christiansund, and steamed out to the *Storeggen* bank. Here we took a series of 10 soundings and 5 hauls of the dredge, after which the vessel pursued her westward course. On the 30th of June we sounded, trawled, and dredged, in 525 fathoms; and on the 1st of July, in 587 fathoms, lat. 63° 5′ N., long. 0° 53′ E. Since our departure from Husø the weather had been uncommonly fine; but on the 1st of July it blew a heavy gale, and from that date to the 15th of August the weather continued exceptionally foul.[1] On the 1st of July, at 10 p.m., the velocity of the wind was 20 metres a second, its direction (true) SSE., and the course of the vessel (true) ESE.; height of the waves 5—6 metres (18 feet). The wind having gradually veered to the south-west, on the afternoon of the 2nd the ship was given a westward course. The wind had fallen off, but the sea was still too high to admit of deep-sea operations. On the 3rd of July we continued steaming slowly westward, with no possibility however of working

[1] *Vide* "Cartes synoptiques journalières, construites par N. Hoffmeyer, directeur de l'institut météorologique Danois," in which part of our meteorological observations are incorporated.

Kl. 6 var Vejret blevet saavidt roligt, at der kunde tages et Lodskud paa 1081 Favne paa 63° 7′ N. Br. 1° 26′ L. V. f. Gr. og en Skrabe den 5te om Morgenen 10′ nordligere, men en om Aftenen paabegyndt Temperaturrække maatte afbrydes, da Vind og Sø atter tiltog fra Sydøst. Den 6te Juli, med Vind fra Syd af indtil 18 Meters Hastighed pr. Sekund, drev vi langsomt nordover, liggende bi for Styrbords Halser og sagte forover gaaende Maskine, da ved Middagstider en Braadsø kom over, som knuste Rækken, Nedgangskappe og Skylight forud og slog Fordækket lækt. Nu sattes Stevnen mod Soerne og for langsomt gaaende Maskine avanceredes smaat sydover. Den følgende Dags Aften kunde atter dampes med fuld Fart og Kursen sattes nu paa Thorshavn, hvor Expeditionen ankrede om Eftermiddagen den 8de.

Med Assistance fra Land blev her den lidte Søskade udbedret. Vejret var under Opholdet i Thorshavn uroligt, tildels stormende, med en Vindhastighed i Vestenvindsbygerne af over 20 Meter pr. Sekund. Udflugter gjordes af Expeditionens Medlemmer, saavel i zoologisk som i mineralogisk Retning. Paa den ligeoverfor Thorshavn liggende Naalsø samledes en Del Mineraler. Efterat Skibet igjen var sejlklart, gik vi med Vøringen søndenom Strømo til Vestmannahavn paa Øens Vestside for at søge gunstigere Lejlighed til at gaa tilsøs, men vendte den næste Dag, den 16de samme Vej tilbage til Thorshavn, hvorfra vi efter et Par Timers Ophold kunde gaa tilsøs.

Kursen sattes østover ud i Færø-Shetland-Renden og om Natten toges et Lodskud paa 148 Favne, 15 Mil ØNØ. for Naalsø. Næste Morgen toges atter et paa 690 Favne 30 Mil fra Naalsø i samme Retning. Kulingen var atter tiltaget, saa at der ikke kunde skrabes, og om Eftermiddagen arbejdede Skibet svært i den oprørte Sø. Kursen holdtes NV$\frac{1}{4}$V. og om Aftenen toges et Lodskud paa 204 Favne, 18 Mil i NØ. for Færøerne. Med VNV.lig Kurs og aftagende Kuling holdtes gaaende til Kl. 8 Form. den 18de, til et Punkt 16 Mil retvisende NNØ. for Færøerne, hvor Dybden fandtes at være 1215 Favne. Her toges Bundskrabninger først med Skrabe og derefter med Trawlnet til om Morgenen den 19de. Samme Dags Aften begyndte den 4de Storm, der varede i noget over 24 Timer. Mod sydvestlig til vestsydvestlig Kuling og svær Sø arbejdedes stadig vestover, i det der den 20de og 21de toges to Lodskud med Temperaturrækker paa Strøget mellem Island og Færøerne. Den 22de om Morgenen bedredes Vejret og vi fik Island i Sigte omtrent ved Portland. Da vi om Aftenen var rukket indtil tvers af Vestmanna-Øerne, fik vi Taage med tiltagende Kuling, og da Barometret viste et raskt Fald, besluttedes det at søge ind under Heima-ey,

the deep-sea apparatus. The violence of the wind had somewhat abated, but there was a heavy sea, the height of the waves being 3 metres (10 feet). On the morning of the 4th, at 6 a.m., the weather was sufficiently moderate to admit of sounding, in 1081 fathoms, lat. 63° 7′ N., long. 1° 26′ W., and on the morning of the 5th we took a haul of the dredge, 10′ farther north; but in the evening it came on to blow again, from the south-east, with a rapidly rising sea, so that a series of temperatures commenced shortly before had to be broken off. On the 6th of July, in a heavy gale from the south, velocity of the wind 18 metres a second, we were drifting slowly north, hove to on the starboard tack, at slow speed, when, about noon, a sea struck the ship on her starboard bow, carrying away the fore bulwark, hatchway, and skylight, and springing the seams of the deck. The vessel was now put head to wind, and we steamed slowly south. By the evening of the following day, we could again run at full speed, and now steered for the harbour of Thorshavn, where the "Vøringen" dropped her anchor on the afternoon of the 8th.

With some assistance from the people of the place, we succeeded in repairing the damage the ship had sustained in the gale. During our stay at Thorshavn the weather was rough and unsettled, at times stormy, the velocity of the wind during the violent westerly squalls reaching 20 metres a second. Divers excursions, zoological and mineralogical, were made by the members of the Scientific Staff. The island of Nolsø, which lies abreast of Thorshavn, furnished interesting mineral specimens. When the ship was ready for sea, we proceeded, coursing south of Strømø, to Vestmannahavn, on the western shore of the island, there to await a favourable opportunity of continuing the cruise, but next day, the 16th, steamed back to Thorshavn, whence, after an hour or two's stay, we resolved on putting to sea.

Standing east, the "Vøringen" steamed out into the Færoe-Shetland channel, and in the night a sounding was taken, in 148 fathoms, 60 miles east-north-east of Nolsø. Next morning we sounded again, in 690 fathoms, 118 miles from Nolsø, in the same direction. Meanwhile, the violence of the gale had again augmented; dredging was out of the question, and in the afternoon the vessel laboured heavily in the agitated sea. Our course lay NW$\frac{1}{4}$W., and in the evening we sounded in 204 fathoms, 73 miles north-east of the Færoe Islands. Steering WNW., with the gale abating, we steamed on till the 18th, 8 a.m., and reached a point 65 miles NNE. (true bearing) of the Færoe Islands, where the depth was found to be 1215 fathoms. Here we explored the bottom, first with the dredge and then with the trawl, till the morning of the 19th. On the evening of that day it was again blowing a gale, the fourth we had encountered, which lasted something more than 24 hours. Steaming up against a strong wind, south-west to west-south-west, and a heavy sea, the ship was kept steadily on her westward course. On the 20th and 21st we sounded twice, and took serial temperatures in the tract between Iceland and the Færoe

den største af Vestmanna-Øerne. Dette lykkedes ogsaa trods Taagen, og Vøringen bragtes til Ankers paa Øens Østside udenfor Indløbet til den Bugt, der danner Havn for Handelsstedet, men som er utilgjængelig for større Fartøjer.

Vort Ophold ved Vestmannaøerne blev længere end paaregnet, da det de følgende Dage fremdeles blæste haardt fra Sydvest og gik svær Sø paa Havet. Den 23de gjordes Excursioner i Land, men den 24de blæste det saa haardt, idet Vindhastigheden gik op i 20 Meter pr. Sekund, at vi ikke kunde ligge for vort Anker, men maatte holde det gaaende hele Dagen i Læ af Øen paa den Maade, at Fartøjet drev udover, indtil der hvor Søgangen begyndte, derpaa dampede vi indover igjen til Ankerpladsen, og saa drev vi igjen udover, en Manøvre der i Dagens Løb gjentoges mange Gange. Den 25de kunde der atter gjøres Exkursioner i Land, men først den 26de var Havet blevet saa roligt, at Expeditionen kunde fortsætte sin Rejse. Kl. $3^{1}/_{2}$ Eftermiddag passeredes Reykjanes, Kl. $6^{1}/_{2}$ Skagen og Kl. 9 ankom Expeditionen til Reykjavik. Her traf vi det danske Stationsskib, Dampskonnerten "Fylla" og de franske Krigsskibe, Dampkorvetten "Dupleix" og Briggen "Beaumanoir," hvis Chefer strax sendte Officerer ombord i Vøringen for at komplimentere, efter almindelig Orlogsskik.

Under Vøringens Ophold i Reykjavik foretog Expeditionens Medlemmer, ledsaget af Næstcommanderende, en Tur til Thingvellir. Vejret vedblev at være yderst uroligt. Allerede Dagen efter vor Ankomst begyndte den 6te Storm og Natten mellem den 28de og 29de Juli laa Vøringen med Dampen oppe og Mandskabet i Søvagt. Desuagtet lykkedes det mig at faa udført absolute magnetiske Bestemmelser i Land, men om at svinge Skibet kunde der ikke blive Tale. Først den 30te om Aftenen blev Vejret saavidt roligt, at Kul- og Vandfyldningen kunde begynde. Den 2den August opdagedes under Opfyringen en Læk paa Kjedlen, hvorfor der atter maatte slukkes af, men det lykkedes Maskinbesætningen ved ihærdigt Arbejde at reparere den saa hurtigt, at Afrejsen kunde finde Sted den næste Dags Aften Kl. 7.

Da Tiden nu var temmelig langt fremskreden, blev den paatænkte Omsejling af Island opgivet, og Tilbageturen lagdes sønden om Island. Den 5te August toges et Lodskud paa 844 Favne paa den sydlige Skraaning af Færø-Islands-Banken. Fra dette Punkt udsejledes til om Aftenen den 7de 240 Kvartmil (60 geogr. Mile) i nordøstlig Retning, hvorunder den sydøstre Islandsbanke blev undersøgt ved Lodskud, Temperaturrækker og Bundskrabninger. Ved den

Islands. On the morning of the 22nd the weather began to abate, and we made Iceland in the vicinity of Portland. By the evening, we had reached a point abreast of the Vestmanna Islands, when a fog came on; the gale, too, had set in again; and this, together with a rapid fall of the barometer, determined us to run for Heima-ey, the largest of Vestmanna Islands, and there ride out the storm. We fortunately succeeded in spite of the fog, and the "Vøringen" let go her anchor on the eastern shore of the island, off the entrance to the bay that forms the harbour of the "town," but which is not accessible to large vessels.

Stress of weather protracted our stay at the Vestmanna Islands. For several days in succession it blew hard from the south-west, and there was a high sea running off the coast. On the 23rd we made excursions about the island, but on the 24th such was the violence of the gale, the velocity of the wind reaching 20 metres a second, that riding at anchor was impossible. The vessel had to be kept going all day long under lee of the land. She was allowed to drift out to where the sea was running high, and then steamed back to her anchorage, a manœuvre which had to be repeated many times in the course of the day. On the 25th we were again able to make excursions on shore; but not till the 26th had the sea gone down sufficiently to admit of continuing the cruise. At 3.30 p.m. we passed Reykjanes; at 6.30, Skagen; and by 9 the Expedition had reached Reykjavik. Here we found the Danish steam-schooner "Fylla," and two vessels belonging to the French navy, — the "Dupleix," steam-corvette, and the brig "Beaumanoir," officers from which were forthwith despatched on board the "Vøringen" to compliment her captain, according to navy-etiquette.

During our stay at Reykjavik, the members of the Scientific Staff, accompanied by the first lieutenant, made an excursion to Thingvellir. The weather still continued very unsettled. On the day after our arrival it again blew a gale, the sixth; and the 28th, after night-fall, the "Vøringen" was lying with the steam up and the sea-watch set. Still, I succeeded in getting absolute magnetical observations on shore; swinging the vessel was out of the question. Not till the evening of the 30th had the weather become sufficiently moderate to allow of our taking in coal and water. On the 2nd of August, when getting up steam, a leak was discovered in one of the boiler-plates, and the fires had to be put out; but, thanks to the engine-men, who worked with a will at repairing the damaged part, we were able to get off on the following day at 7 o'clock in the evening.

The season being now comparatively far advanced, we had to relinquish our original intention of circumnavigating Iceland, and the homeward course of the "Vøringen" was laid south of the island. On the 5th of August we sounded in 844 fathoms, on the southern slope of the Færoe-Iceland ridge. From this point we stood north-east, exploring, by means of soundings, dredgings, and serial temperatures, the south-eastern section of the Iceland banks,

første Skrabning satte Skraben sig fast i den ujevne, haarde Bund, og efter langvarige Manøvrer for at faa den løs, maatte Touget sprænges. Vejret holdt sig taaget og regnfuldt med sydlig og sydøstlig Bris og uroligt Hav, hvorfor Undersøgelsen af Partiet mellem vor nordligste Station og Langanes, den nordøstlige Pynt af Island, opgaves, og Kursen sattes østover.

Den 8de loddedes og trawledes i 1861 Favne, det største Dyb, vi fandt i 1876, paa 65° 48′ N. Br. 3° 7′ L. V. f. Gr. Kulingen tiltog imidlertid igjen, saaat der sattes igang østover med kun halv Fart, og den næste Dags Eftermiddag blev Stevnen sat op mod Søerne, da Skibet slingrede for voldsomt med Søen tvers. Om Morgenen den 10de August sattes atter Kurs for Station, og Kl. 10 toges Lodskud paa 1539 Favne. Uagtet det var stiv Kuling (Vindhastighed 10 til 16 Meter pr. Sekund) og uroligt Hav, blev dog Bundskrabning udført fra Kl. 11 Form. til Kl. 7 Aften, hvorefter Kursen atter sattes østover, men om Morgenen den 11te maatte Stevnen atter sættes mod Søerne. Den næste Nat sejledes nogle Timer Kurs, og da Station naaedes, toges, uagtet det ugunstige Vejr fremdeles vedvarede med stiv Kuling og høj Sø, Lodskud og Temperaturrække. Da Dybden ikke var mere end 600 Favne, og Rejsen saavidt fremskreden, at et Tab af Apparater var af mindre Betydning, forsøgtes det Experiment at bruge til Bundskrabning Skrabe og Trawl paa en Gang, idet Otertrawlen gjordes fast bag efter Skraben. Experimentet lykkedes ogsaa forsaavidt, at Skraben kom vel ombord igjen, men Trawlen, der ikke hurtigt nok kunde hales ombord i sin hele Længde, blev grebet af Skruen, førend denne kunde standses. Vi satte da Sejl til og holdt undaf Vejret, og med megen Besværlighed, paa Grund af den høje Sø, blev saa meget af Trawlen bortkappet ved Hjelp af Knive og skarpe Spadeblade, fæstede til lange Stager, at Skruen efter et Par Timers Forløb atter kunde sættes i Gang. Kursen sattes nu mod Land, men næste Dag maatte atter Stevnen sættes mod Søerne, indtil en efter Middag erholdt Solhøjde gav Skibets Plads, saaledes at der kundes styres lige mod Halten Fyr, hvis Taarn ogsaa nogle Timer senere viste sig ret forud. Samme Dags Aften bragtes Vøringen til Ankers i Haltens Havn, efter i Løbet af 6 Uger at have udholdt 8 Storme. Den næste Dag, den 14de August, gik Expeditionen til Namsos.

I Namsos laa Expeditionen i 6 Dage, og under dette Ophold blev taget magnetiske og astronomiske Observationer i Land. Den 20de August gik Expeditionen atter tilsøs, og samme Dags Aften paabegyndtes Arbejderne atter udenfor Kysten. Med vestlig Kurs toges en Lodskudrække

and by the evening of the 7th had run 240 miles. At the first haul, the dredge caught against the hard and rugged bottom, and we were obliged to break the rope, after manifold manœuvres to disengage the apparatus. The weather still continuing wet and foggy, with strong winds from the south and south-east and a heavy sea, we decided on giving up the investigation of the tract between our most northerly observing-station and Langanes, the north-eastern promontory of Iceland, taking instead an eastward course.

On the 8th we sounded and trawled in 1861 fathoms, the greatest depth measured in 1876, lat. 65° 48′ N., long. 3° 7′ W. Meanwhile, it was again blowing so hard that we had to steam eastward at half speed; and on the afternoon of the following day the vessel was put head to sea, as she rolled too heavily with the sea on her beam. On the morning of the 10th of August we stood for the next observing station, and at 10 a. m. took a sounding in 1539 fathoms. Though it blew a gale (velocity of the wind from 10 to 16 metres a second) and the sea ran high, still we managed to dredge the bottom, — an operation which lasted from 11 a. m. to 7 p. m. Proceeding then on our eastward course, the next morning heavy weather again compelled us to put the ship with her head to the sea. During the night, the wind having fallen off a little, she was able to steam on her course for a few hours; and, arrived at the next observing station, we took, notwithstanding the very unfavourable weather, — it was still blowing hard with a heavy sea, — both soundings and serial temperatures. The depth here not exceeding 600 fathoms, and the advanced stage of the cruise rendering a possible loss of apparatus of less moment, the experiment was tried of working trawl and dredge simultaneously, the otter-trawl being made fast behind the dredge. The experiment succeeded, in so far at least as the dredge came safely on board; but the trawl, from its great length, could not be hove quick enough, and fouled the propeller, ere there was time to stop the engines. Getting sail on the ship, we ran before the wind, and with great difficulty, owing to the heavy sea, succeeded, after a couple of hours' unremitting exertions, in cutting away sufficient of the trawl, by means of knives and sharpened spade-blades at the end of long poles, to free the propeller. We now stood for the land, but next day the vessel lay to with her head to the sea till an observation of the sun's altitude, taken an hour after noon, had given us her position, and we could steer direct for the Halten lighthouse, the tower of which hove in sight a few hours after. On the evening of that day the "Vøringen" was moored in the harbour of Halten, having encountered a continued succession of heavy gales — no less than 8 — in the course of her six weeks' cruise. On the morrow, the 14th of August, the Expedition proceeded to Namsos.

At this place we remained 6 days, our stay being chiefly devoted to the taking of magnetical and astronomical observations on shore. On the 20th of August the Expedition again put to sea, and in the evening the exploratory work off the coast was resumed. Standing west,

paa 31 Stationer med 1 Mils Afstand indbyrdes, samt en Bundskrabning. Kystbankens Afheld mod Ishavsdybet fandtes først i en Afstand af 25 Mil fra Land og først her fandtes, i 381 Favne, iskoldt Vand ved Bunden. Kursen sattes derefter sydover og Opgangen fra Dybet af den samme Banke blev bestemt paa 64° Bredde, hvor der blev taget 6 Lodskud, 2 Temperaturrækker og 2 Bundskrabninger. Dette Arbejde blev udført til om Aftenen den 22de August, og da ophørte ogsaa det gode Vejr, som vi siden Ankomsten til Namsos havde havt.

I Taage og Kuling gjordes Land næste Morgen, den 23de August, ved Ona Fyr, hvor Lods kom ombord, og om Eftermiddagen ankredes ved Molde. Den 24de blev der loddet, taget Temperaturrække og skrabet i Romsdalsfjorden, og samme Dags Aften ankom Expeditionen til Aalesund. Her kom der Kl. 8 om Aftenen en Stormbyge, der rev Skibet løs fra sine Fortøjninger, og først Kl. 2 om Morgenen blev det atter bragt paa sikker Ankerplads igjen. Den næste Formiddag afgik vi fra Aalesund, laa om Natten i Florø og ankom Lørdag Middag den 26de August til Bergen.

Samtlige Expeditionens Medlemmer debarkerede samme Dag, og Mandag Morgen begyndte Desarmeringen, idet alle Expeditionens Sager bragtes i Land paa Marinens Værft, hvor det fornødne Magazinrum velvilligen var stillet til Expeditionens Raadighed. Samtidig udtoges Indredningen, og Skibet klargjordes til Fragtfart ved D'Hrr. Brunchorst & Dekkes Værft, hvorfra det den 7de September afleveredes til Rederiet.

we took a series of soundings at 31 Stations, 4 miles apart, and one haul of the dredge. The slope of the coastal bank towards the basin of the Arctic Ocean was found to commence 100 miles from land, and here, in 381 fathoms, we first met with bottom-water of 0°. Proceeding then on a southward course, the rise of the bank was determined in lat. 64° N., and here we took 6 soundings, 2 serial temperatures, and 2 hauls of the dredge. This deep-sea work was steadily prosecuted till the evening of the 22nd of August, when a gale of wind put an end to the spell of fair weather we had enjoyed after reaching Namsos.

Steaming southward in a fog and a heavy sea, we made land the next morning, the 23rd of August, near the Ona lighthouse; soon after a pilot came on board, and in the afternoon the "Vøringen" cast anchor at Molde. The next day we sounded, took a series of temperatures, and dredged in the Romsdalsfjord, the Expedition proceeding that day as far as Aalesund. At 8 p.m. the ship, struck by a violent squall, broke from her moorings, and it was 2 o'clock in the morning before she got safe anchorage. On the forenoon of the following day we left Aalesund, anchored for the night at Florø, and arrived at Bergen on Saturday the 26th of August, about noon.

The members of the Scientific Staff disembarked the same day. In the course of the next week the instruments, apparatus, and other things belonging to the Expedition were conveyed to the Royal Navy Yard (storage-room had been kindly placed at my disposal), and the crew paid off. The fittings below deck were then removed, and the vessel cleared for the freight-trade, in Messrs Brunchorst & Dekke's dockyard, where, on the 7th of September, she was given up to the owners.

1877.

Den for dette Aar vedtagne Plan var saalydende:

Fartøjets Udrustning og Bestemmelsen af dets magnetiske Konstanter antages færdige til den 1ste Juni.

Ved Studiet af Varmeforholdene i Dybet over Bankerne udenfor Vestkysten har det vist sig, at der endnu savnes nogle Temperaturrækker i den norske Rende. For at faa disse, begyndes Vejen til det egentlige Undersøgelsesfelt saaledes, at man fra Bergen gaar direkte tilsøs og, følgende Rendens Bund, tager nogle Temperaturrækker i denne. Længere Nord kunne nogle af forrige Aars Temperaturrækker verificeres.

Det første egentlige Arbejdsfelt er de norske Kystbanker nordenfor Namdalen.

Efter de Observationer, som foreligge, er det sandsynligt, at Havbroen, hvor Banken kaster sig ned mod Ishavsdybet, og hvor det iskolde Vand begynder ved Bunden,

1877.

The Scheme approved for this year was as follows: —

The equipment of the vessel and the determination of her magnetic constants are assumed to have been completed by the 1st of June.

Extended research into the thermal conditions of the deeper strata on the banks off the West Coast of Norway, has shown a few serial temperatures to be wanting for the Norwegian Channel. The Expedition will, therefore, on leaving Bergen, at once put to sea, and, following the axis of the channel, commence its exploratory work by taking serial temperatures. Farther north, a few of last year's serial temperatures might be verified.

The Norwegian coastal banks north of Namdalen will form on this cruise the first extensive field of exploratory research.

Judging from the observations already taken, it is highly probable that the edge of the bank where the sea-bottom begins to slope down towards the depths of the Arctic

ligger mindst 25 Mil ud fra Kysten. Mellem Røst og det Punkt udenfor Namdalen, hvor Expeditionen ifjor fandt omkring 60 Favnes Dyb med Fjeldbund 10 Mil af Land, antages det muligt, at der gaar en mere eller mindre sammenhængende Fjeldkam. Havbroens og den formodede Fjeldkams Sted og Naturforhold danne fremtrædende Punkter i Undersøgelsen af Bankerne. Denne foregaar ved Opgaaelse af Tversnit lodret mod Kysten. Tversnittene tages — i Overensstemmelse med forrige Aars — i en indbyrdes Afstand af 12 til 13 geografiske Mil. Deres indre Grændse er den yderste Linie for den specielle hydrografiske Kystundersøgelse. Deres ydre Grændse er der, hvor Temperaturen ved Havbunden er — 1° eller henimod denne.

Ocean, and where the temperature at the bottom falls below 0° C., lies not less than 100 miles distant from the coast. The section of the sea-bed between Røst and the point off Namdalen where, on last year's cruise, the depth, 40 miles from land, was found to be 60 fathoms, with a rocky bottom, will possibly prove to be traversed by a more or less continuous submarine ridge. To determine the exact position of the edge of the bank and of this supposititious ridge, and thoroughly to investigate their physical conditions, form important points in the exploration of the banks. This can be done by means of transverse sections perpendicular to the coast, at distances, as on last year's cruise, of about 50 miles. The inner limit of these sections to coincide with the extreme boundary line for the special hydrographic Coast Survey, their outer extending to where the temperature at the bottom is about — 1°.

Til Bestemmelse af Temperaturforholdene kræves i hvert Tversnit foruden Temperaturen ved Bunden ved hvert Lodskud, mindst 3 Temperaturrækker: en ved den indre Grændse, en ved Havbroen, paa dens indre Kant, og en ved Snittets ydre Grændse. Lodskuddenes Antal beror paa, om man under Arbejdet finder Bunden mere eller mindre jevn.

To determine the thermal conditions, at least 3 serial temperatures will have to be taken in each section, exclusive of the temperature registered with each bottom-sounding, viz. — one at the inner limit, one on the edge of the bank, and one at the outer limit of the section. The number of soundings will depend on the contour of the bottom, whether it be more or less undulating.

For at levne saameget Tid som muligt til Arbejderne i det store Ishavsdyb og ved Jan Mayen samt Grønlandsisen, medtages ved Bankernes Undersøgelse, i hvert 3die Tversnit, Undersøgelsen af Umbellularia-Regionen indtil et Dyb af 1000 Favne. Skulde Forholdene tillade det, kunne ogsaa flere af Banktversnittene udvides til denne Udstrækning. Under Arbejdet paa Bankerne og i Umbellularia-Regionen antages det hensigtsmæssigt at anløbe Bodø.

With the object of prolonging the period for the exploration of the great Arctic basin, the depths off Jan Mayen, and the Greenland ice-barrier, it is deemed advisable that the work on the banks be made to embrace, in every third section, down to a depth of 1000 fathoms, the investigation of the *Umbellularia* region. Circumstances permitting, several of the transverse sections may be extended accordingly. When exploring the banks and the *Umbellularia* region, the Expedition should touch at Bodø.

En Temperaturrække i Vestfjorden, udført med de nyeste Dybvandsthermometre, søges erholdt saavel paa Rejsen opover i Juni som paa Tilbagerejsen i August, til Undersøgelse af det abnorme Forhold, som fandtes her i Sommeren 1875, idet Temperaturen havde et Minimum i 70 Favnes Dyb. Da de zoologiske Undersøgelser i Vestfjorden hidtil kun omfatte Kysternes Fauna, søges Anledningen benyttet til zoologiske Arbejder i denne Fjord i større Afstand fra Land.

A series of temperatures should, if possible, be taken in the Vestfjord with the latest deep-sea registering thermometers, both on the passage north in June and on the homeward course in August, to determine the abnormal condition observed here in the summer of 1875, viz. of a minimum temperature at a depth of 70 fathoms. Zoological investigations in the Vestfjord having hitherto been confined to the littoral fauna, the naturalists accompanying the Expedition will take every advantage of the opportunity afforded them to explore this fjord at a greater distance from land.

Magnetiske absolute Observationer søges udført paa Røst, hvor Forholdene derfor ifølge Lieutenant Petersens Observationer i 1875 antages gunstige, og hvor man har det mest fremskudte Punkt til Sammenligning med de eventuelle magnetiske Observationer paa Grønlandsisen.

Absolute magnetical observations will, if possible, be taken at Røst, — the most advanced point on the coast, — where the physical conditions, as determined by lieutenant Petersen in 1875, are, it is believed, sufficiently favourable, for comparison with the magnetical observations to be instituted on the Greenland ice-barrier.

I Løbet af Juni Maaned antages, under gjennemsnitlige Vejrforhold og med den fra ifjor hentede Erfaring, Undersøgelsen af Bankerne og Umbellularia-Regionen efter denne Plan at kunne naa til Bredden af Tromsø.

By the end of June, in moderately fair weather, the exploration of the banks and the *Umbellularia* region will, it is believed, inferring from last year's stormy cruise, have reached the latitude of Tromsø.

I Tromsø antages Expeditionen sidst i Juni eller først i Juli at kunne blive udrustet til en længere Rejse vestover.

Refitting at Tromsø for a cruise westward of greater duration, the "Vøringen" will, it is hoped, be ready to leave that port by the end of June or the beginning of July.

Man gaar først efter Linien Andø—Jan Mayen ud i Ishavsdybet, undersøger dette og dets Skraaninger paa begge Sider. Omkring Nordøstenden af Jan Mayen som Centrum foretages nogle kortere Rækker Lodskud mod Nordøst, mod Nord og mod Nordvest. Paa dette Strøg nemlig, der antages at danne den islandske Vulkan-Regions yderste Forbjerg mod Nordøst, synes Bunden at falde særdeles brat af mod Dybet til de nævnte Sider.

Under den sandsynlige Forudsætning, at Adgangen til Jan Mayen ikke er spærret af Is, forsøges det at lande paa Øen til Foretagelse af Undersøgelser i geografisk, geologisk, hydrografisk, zoologisk, botanisk Retning m. v.

En Undersøgelse af Naturforholdene i Havet paa Vest- og Sydsiden af Jan Mayen søges udført. Der er nemlig Grund til at antage, at Jan Mayen er forbundet med Island ved en undersøisk Ryg.

For at undersøge Forholdene paa Grændsen mellem den varme Overfladestrøm fra Atlanterhavet og den kolde Polarstrøm i Grønlandshavet, opsøges Grønlandsisen i Nordvest for Jan Mayen. Naar Undersøgelserne langs et Stykke af Grønlandsisen ere afsluttede, styres til et Punkt omtrent midtvejs mellem Island og Jan Mayen, og derfra undersøges Tversnittet over Ishavsdybet i Retning af Ranen. Herved vil man kunne faa rede paa den formodede undersøiske Ryg mellem Island og Jan Mayen. Naar det sidstnævnte Tversnit er oparbejdet indtil dets tidligere undersøgte norske *Umbellularia*-Region, sejles til Tromsø, under Forudsætning af, at Tiden senere tillader, i August, flere Arbejder nordenfor Tromsø.

Naar Juli Maaned antages medgaaet til Jan Mayen-Turen, vil den første Halvdel af August kunne anvendes til Undersøgelse af Bankerne, Havbroen og endel af Ishavsdybet mellem Norge og Syd-Spidsbergen. Som Østgrændse sættes Linien Nordkap, Bjørneøen, Sydkap.

Den sidste Halvdel af August vil tiltrænges til Tilbagerejsen til Bergen og Desarmering.

Her course west will at first coincide with a line extending from Ando to Jan Mayen, and thence to the Arctic Ocean, the basin and slopes of which the Expedition has to investigate. From the north-eastern extremity of Jan Mayen will be taken a few short series of soundings in a north-easterly, a northerly, and a north-westerly direction: for off this point, which is supposed to form the north-eastern promontory of the volcanic region of Iceland, the bottom would appear to sink precipitately in those directions.

On the probable assumption that Jan Mayen is not inaccessible from ice, the Scientific Staff will land on the island, and prosecute exploratory work in divers branches — geographical, geological, hydrographical, zoological, botanical, &c.

The physical and biological conditions of the sea off the western and southern shores of Jan Mayen, should if possible be investigated, there being some reason to infer that a submarine ridge connects that island with Iceland.

To investigate the conditions where the warm surface-current from the Atlantic meets the glacial Polar flow in the Greenland sea, the Expedition will stand north-west of Jan Mayen when making for the Greenland ice-barrier. After exploring part of the Greenland ice-barrier, the Expedition will proceed to a point about midway between Iceland and Jan Mayen, and from thence investigate the bed of the Arctic Ocean in the direction of Ranen. The existence or non-existence of a submarine ridge connecting together Jan Mayen and Iceland will then be definitively settled. When the last-mentioned section of the Arctic basin has been explored throughout, irrespective of its Norwegian *Umbellularia* region, investigated previously, the Expedition will return to Tromsö, provided there be time for subsequent exploratory work (in August) north of that port.

If, as expected, the Expedition get back from Jan Mayen by the end of July, the first half of August can be devoted to further investigation of the banks, and part of the Arctic basin between Norway and the southern extremity of Spitzbergen. A line tangent to the North Cape, Beeren Eiland, and South Cape marks the eastern limit of the tract to be explored.

The latter half of August will be needed for the passage home to Bergen, and for discharging the vessel.

De videnskabelige Arbejder udføres væsentlig paa samme Maade som i 1876.

Ved de zoologiske Arbejder lægges ved Siden af Fangst med Skrabe, Trawl og Svabere, særlig Vægt paa Anvendelse af Drivgarn og Net i intermediære Dybder, samt Fiskeri paa Bankerne. Paa Jan Mayen antages Fuglefangst at burde være Gjenstand af Betydning og ved Grønlandsisen muligens Fangst af Sæl og Isbjørn m. m.

The scientific work of the Expedition to be carried out in all essential particulars as in 1876.

With regard to the zoological work, especial stress is laid on the use of the surface-net, and of the drag-net in intermediate depths, apart from that of the dredge, trawl, and swabs, as also on fishing when exploring the banks. During the stay at Jan Mayen, some time should, it is thought, be devoted to collecting ornithological spec-

Ved Lodskuddene søges bestemt Bankernes Form og Udstrækning, samt den Maade, paa hvilken Bunden falder af fra disse til de største Dybder i Ishavsdybet. Det er af fundamental Betydning for Forstaaelsen af Havets og de tilgrændsende Landes orografiske og geologiske Forhold, ligesom for Dyrelivets Udbredelsesforhold, at faa afgjort, om Bunden falder jevnt af mod Dybet, eller om den falder af i Trin, Terrasser eller Afsatser med mellemliggende Plateauer. Lodskuddenes Plads og Antal bestemmes derfor med disse Hensyn for Øje.

Maalingerne af Havets Temperatur i Dybet udføres i den Udstrækning, som er nødvendig til en sikker Bestemmelse af Dybets Isothermer i de efter denne Plan opgaaede Tversnit. Der tages Hensyn til det hensigtsmæssige i, at Punkterne i Tversnittene ogsaa kunne anvendes til Længdesnit. De nyeste Dybvandsthermometre anvendes saa ofte som muligt ved Siden af det ifjor brugte.

Ved hvert Lodskud tages Vandprøve fra Dybet og paa udvalgte Steder fra intermediære Dybder. Alle Vandprøvers specifiske Vægt bestemmes.

Ved hvert Lodskud tages Bundprøver, der opbevares til videre Undersøgelse. Af de med de zoologiske Fangstapparater optagne og sigtede Materiale af Havbunden tages Prøver til Opbevarelse.

De chemiske Arbejder udføres væsentlig som ifjor. Den specifiske Vægt af Havoverfladens Vand bestemmes en til to Gange daglig, og oftere paa Steder, hvor Strømforhold eller andre Forhold gjøre det ønskeligt.

Iagttagelsen af Strømmen i Havet søges udført, naar Naturforholdene gjøre det ønskeligt og Vejrforholdene muligt.

Magnetiske Observationer søges udført ombord i Søen, navnlig lægges Vægt paa Erholdelsen af Misvisningsobservationer. Absolute Bestemmelser søges udført paa Røst og paa Grønlandsisen, foruden ved Bestemmelsen af Skibets magnetiske Constanter i Husø, og desuden, hvor Lejligheden ellers maatte findes, som i Bergen, Bodø, Tromsø m. fl.

Geologiske Undersøgelser foretages paa Jan Mayen, om Landgang der er mulig, i al den Udstrækning, som Forholdene tillade. Paa Jan Mayen vil astronomisk-geografiske Stedbestemmelser, topografiske og hydrografiske Undersøgelser være af største Interesse at faa udført. En Stedbestemmelse paa Røst — i Forbindelse med de magnetiske Observationer — vil være ønskelig, da Stedet ikke er forbundet med det trigonometriske Net.

imens; and at the Greenland ice-barrier there might, perhaps, be opportunity of capturing a few seals, with an occasional shot at a Polar bear.

Deep-sea soundings will be taken to determine the contour and extent of the coastal banks, as also their slope, or how the bottom shelves down into the greatest depths of the Arctic Ocean. It is a point of fundamental importance in studying the orographical and geological conditions of the sea and the countries it surrounds, and the distribution of animal life in the ocean, to find whether the bottom slopes gradually down to the depths, or descends, as it were, step by step, in terraces, with interjacent plateaus. Hence, the position and number of the soundings will have to be determined with this object in view.

The temperature of the sea will be taken to the extent required for an indisputable determination of the isotherms of the transverse sections explored in accordance with the present scheme. Attention is directed to the position of the observing points in the transverse sections, which should admit of their being applied to longitudinal sections. Whenever practicable, the temperature shall be registered with the latest deep-sea thermometers as well as with the instrument used on last year's cruise.

With every sounding, a sample of water shall be brought up from the bottom, and in specially selected localities also from intermediate depths. All the samples to have their specific gravity determined.

With every sounding, a sample of the bottom shall be obtained, and preserved for subsequent examination. Samples of the sifted material brought up from the bed of the ocean with the dredge or trawl will also be preserved.

In the chemical work there will be no essential change. The specific gravity of the surface-water shall be registered once or twice a day, and more frequently in localities where the action of currents or other exceptional conditions may render it desirable.

Observations on ocean-currents will be made wheresoever the attendant physical conditions may render them desirable and the state of the weather practicable.

Magnetical observations shall, if possible, be taken at sea, especial stress being laid on obtaining determinations of the variation of the compass. Absolute determinations shall, if possible, be performed at Røst and on the Greenland ice, exclusive of those for the ship's magnetic constants to be made at Husø; and wheresoever else opportunity may be afforded, as at Bergen, Bodø, Tromsø etc., and other places.

Geological investigations will be undertaken on the island of Jan Mayen, should the Expedition succeed in landing there. Peculiar interest would likewise attach to astronomical determinations of latitude and longitude, as also to topographical and hydrographical observations made on that island. In connexion with the magnetical observations instituted at Röst, it will be desirable to perform determinations of latitude and longitude, that locality not being included in the trignometrical net of the country.

Botaniske Undersøgelser og Indsamlinger søges gjort paa Jan Mayen i størst mulig Udstrækning.

De meteorologiske Iagttagelser ombord udføres i alt væsentligt som i 1876.

Ligesom det foregaaende Aar overtoges Dampskibet "Vøringen" af Expeditionen den 14de April og Indredningsarbejderne udførtes ved samme Værft.

Den 19de Maj paamonstredes Mandskabet, og Kl. 2 om Morgenen den 23de Maj afgik Skibet til Husø, hvor jeg agtede at tage de til Fox-Cirkelens senere Benyttelse nødvendige forberedende Observationer. Efter Ankomsten hid opdagedes imidlertid en Fejl i agterste Krumtappinde, og da Vejret desuden var til Hinder for Observationernes Udførelse, returneredes strax til Bergen, hvor ny Mellemaxel blev indsat. Dette Arbejde var færdigt den 31te Maj, men Expeditionens Afgang blev yderligere forsinket derved, at Mr. Macintosh i London, der havde paataget sig til første Halvdel af Maj at levere nye Accumulatorstrenge, havde glemt Ordren og kunde ikke levere dem før 10de Juni. Der blev derfor gjort et nyt Forsøg paa at erholde de forberedende magnetiske Observationer, men det mislykkedes fuldstændigt paa Grund af det yderst urolige Vejr i Husø.

Den 11te Juni embarkerede i Bergen Professorerne Mohn og Sars, Overlæge Danielssen og Landskabsmaler Schiertz samt Overlæge Hansen, der havde erholdt Indredepartementets Tilladelse til at være med som Passager til Tromsø, hvor Kjøbmand Friele skulde støde til Expeditionen. Da Hr. Svendsen, der var Expeditionens Kemiker det første Aar, havde af Helbredshensyn meldt Forfald, blev i hans Sted antaget Hr. H. Tornøe, der under Professor Waages personlige Ledelse havde arbejdet paa Laboratoriets Indredning siden den 23de Maj. For at vinde Tid besluttedes at gaa Accumulatorerne imøde til Stavanger, og her kom de ombord den 13de Juni, hvorefter Expeditionen strax gik tilsøs.

Omtrent 3 Mil SV. for Udsire toges en Temperaturrække, og Dagen efter en lignende tvers af Feje (60° 42′ N. Br.), hvorefter Kursen sattes direkte paa Station No. 96 (66° 9′ N. Br., 3° 0′ L. Ø. f. Gr.), der naaedes Kl. 6 Morgen den 16de Juni.

Ved at tage 54 Lodskud, 6 Skraber, 3 Trawler og 7 Temperaturrækker undersøgtes 3 Tversnit udenfor Kysten mellem Foldenfjord og Vestfjorden af tilsammen 115 g. Miles Længde. Det nordligste af disse Snit gik helt fra 67° 53′ N. Br. og 5° 12′ L. Ø. f. Gr. til hen imod Trænen (66½° N. Br. 12° L. Ø. f. Gr.). Efter at have taget en Temperaturrække i Vestfjorden, ankom Expeditionen

Botanical work, comprising collections of the flora, will, if possible, be prosecuted on Jan Mayen.

The meteorological observations on board will be made essentially as in 1876.

As in 1876, the S.S. "Vøringen" was on the 14th of April given up by her owners to the agent of the Expedition, and her nautical equipment again undertaken by Messrs Brunchorst and Dekke.

On the 19th of May the crew came on board, and on the 23rd, at 2 o'clock in the morning, the vessel left Bergen for Husø, where I purposed taking the preliminary observations indispensible for the subsequent use of the Fox-circle. But, on arriving at that island, a defect was discovered in the pin of the after-crank, and the weather, too, being very unfavourable for such observations, we returned at once to Bergen, and had a new shaft put in. This was got done by the 31st of May; but unfortunately the final departure of the Expedition had to be still further delayed, Mr. Macintosh, the London manufacturer, who was to have furnished new straps for the accumulators, having overlooked the order, and being in consequence unable to execute it before the 10th of June. During this interval a fresh but, owing to the boisterous weather at Huso, wholly abortive attempt, was made to obtain the preliminary magnetical observations.

On the 11th of June Professors Mohn and Sars, Dr. Danielssen, Mr. Schiertz, artist, and Dr. Hansen, embarked in Bergen. Dr. Hansen, who was not a member of the Scientific Staff, having permission from the Home Department to proceed as passenger to Tromsø, where Mr. Friele was to join the Expedition. Mr. Svendsen, chemist to the Expedition on the first year's cruise, having by reason of ill-health been compelled to retire, Mr. H. Tornøe, who, since the 23rd of May, under the personal guidance of Professor Waage, had been at work fitting up the Chemical Laboratory, was engaged in his stead. Time being precious, we resolved on running south, to await in Stavanger the arrival of the new accumulators, which reached that place on the 13th of June; and having got them on board, the Expedition immediately put to sea.

About 12 miles south-west of Utsire we took a series of temperature-soundings, and on the following day another, off Feje (lat. 60° 42′ N.), after which the Expedition stood for Station 96 (lat. 66° 9′ N., long. 3° 0′ E.), arriving there on the 16th of June, at 6 o'clock in the morning.

Three transverse sections off the coast, between the Foldenfjord and the Vestfjord, measuring together 460 miles in extent, were now explored, by taking 54 soundings, 6 hauls of the dredge, 3 of the trawl, and 7 serial temperatures. The most northerly of these sections extended from a point in lat. 67° 53′ N. and long 5° 12′ E. to a point in the immediate vicinity of Trænen (lat.

den 23de Juni til Bodø, hvor Provisioner indtoges, og Kronometrenes Stand undersøgtes.

$66\frac{1}{2}^{0}$ N., long. 12° E.). After taking a series of temperatures in the Vestfjord, the Expedition stood for Bodø, reaching that place on the 23rd of June. Here we took in a supply of fresh provisons and got the chronometers rated.

Den 25de Juni gik vi til Hopen i Saltenfjorden for at fylde Vand, og derfra om Natten over Vestfjorden til Røst, idet der paa Vejen toges en Række Lodskud. Ved Røst foretoges Deviationsprøve samt magnetiske og astronomiske Observationer i Land. Det viste sig imidlertid, at Stedet mod Formodning var uskikket til magnetisk Basis-Station, idet Declinationen kunde variere hele 7° paa to nærliggende Øer.

On the 25th of June the "Vøringen" steamed up to Hopen, in the Salten Fjord, a good place for watering, and in the night stood across the Vestfjord to Røst, taking by the way a series of soundings. At Røst the ship was swung for deviation, and magnetical and astronomical observations were taken on shore. Contrary to expectation, this place proved wholly unsuited for a magnetical base-station, the declination on two adjacent islands varying as much as 7°.

Om Middagen den 28de gik Expeditionen atter tilsøs mellem Røst og Værø, og i Løbet af to Dage oparbejdedes 3 Tversnit mellem Røst og Hadselfjorden, hvor vi løb ind Lørdagen den 30te Juni. Den paafølgende Søndag laa Expeditionen til Ankers i Sundet ved Sortland. Mandag Morgen gik vi atter tilsøs mellem Langø og Andø, og fandt Bankens Eg her meget nærmere Land end tidligere. Om Natten gik vi noget længere ind paa Banken, og her fiskedes fra Borde stor Torsk, Lange, Brosme og Kveite i betydelig Mængde med Haandsnøre. Den næste Dag, 4de Juli, fortsattes atter Rejsen udover i et længere Snit indtil 70° N. Br. og 6° 15′ L. Ø. f. Gr., paa hvilket Punkt der arbejdedes hele Dagen den 5te Juli i 1710 Favnes Dyb med Lodning, Temperaturrække, Skrabe og Trawl i et usædvanligt roligt og smukt Vejr. Herfra styredes igjen østover, under stadigt Arbejde paa en Række Stationer, til Malangenfjorden, hvis Munding passeredes om Formiddagen Søndag den 8de Juli. Samme Dags Middag ankrede Expeditionen i Tromsø.

On the 28th, about noon, the Expedition again put to sea, between Røst and Værø, and in the course of 2 days investigated 3 transverse sections, between Røst and the Hadselfjord, reaching the latter locality on Saturday the 30th of June. The next day being Sunday, the "Vøringen" lay at anchor in Sortland Sound. On Monday morning we again put to sea, between Langø and Andø, and struck the edge of the bank considerably nearer land than we had done in any other locality. After night-fall we steamed farther in shore, and took numbers of large cod, ling, torsk, or tusk, and halibut, fishing with hook and line from the ship's side. On the day following, the 4th of July, we pursued our outward course to a point in lat. 70° N., long. 6° 15′ E.; and here the Expedition passed the whole of the 5th, prosecuting exploratory work at a depth of 1710 fathoms, — sounding, dredging and trawling, and taking serial temperatures, in weather remarkably calm and fair. Again steering east, we kept on steadily, working at a number of stations, till we reached the Malangen Fjord, the mouth of which was passed on the forenoon of Sunday, the 8th of July. The same day, shortly after noon, the "Vøringen" dropped her anchor at Tromsø.

Fra Røst af var taget 45 Lodskud, 5 Skraber, 5 Trawler og 8 Temperaturrækker. Ved denne Lodning opdagedes, at Atlanterhavs-Dybet eller Ishavsdybet her trænger ind i Banken, hvorved der dannes en Eg paa lignende Maade som ved Storeggen udenfor Romsdalskysten. Men denne nordlige Eg, som blev kaldt "Vesteraalseggen," har en ganske anden Udstrækning end Storeggen. Vesteraalseggen begynder omtrent 15 geogr. Mil retvisende Vest af Røst og strækker sig herfra nordøstover parallel med Lofotens Øgruppe i 10 til 11 Miles Afstand fra Land til Vest af Hadselø, hvor den bøjer mere østover ind mod Land. Ved Nordpynt af Langø er Kanten af Eggen ikke mere end 4 g. Mil fra Land. Den tager i Nord for Andenes og i Vest for Kvalø en mere nordlig Retning igjen, og paa $70\frac{1}{2}$ Grads Bredde bøjer Isobatherne mere vestover, idet Affaldet af Banken antager en mere flaa Form. Vesteraalseggens Længde er saaledes omtrent 60 g. Mile og Bunden falder af mod NV. fra 100 til 1400 Favne paa en Distance af 5 Mil, hvilket, naar Talen er om Havbund, maa kaldes et stærkt Affald. Da de samme Fiske-

On our course from Røst we took 45 soundings, 5 hauls of the dredge, 5 of the trawl, and 8 serial temperatures. These soundings disclosed an important fact, viz. in showing that along this line the basin of the Arctic Ocean cuts deep into the bank, forming an edge, as at Stor-Eggen, off the coast of Romsdal. But this northern edge, to which we gave the name of "Vesteraals-Eggen," differs widely from the Stor-Eg in extent. The Vesteraals-Eg commences about 60 miles due west of Røst, stretching thence in a north-easterly direction, parallel to the Lofoten Islands, distant 40 or 44 miles from the coast, on to the west of Hadselø, where it makes a somewhat easterly landward bend. At the northern extremity of Langø, the edge is not more than 12 miles from land. North of Andenes and west of Kvalø, it again takes a more northerly direction, and in lat. 70° 30′ N. the isobaths bend more to the west, the slope of the bank being less sudden here. The length of the Vesteraals-Eg reaches accordingly about 240 miles, and the bottom shelves, in a north-westerly direction, over a distance of 20 miles, from 100 fathoms

sorter findes paa Vesteraalseggen som paa Storeggen, og da Bunden har en lignende Formation og er af samme Beskaffenhed, er der en høj Grad af Sandsynlighed for, at det samme Slags Fiskeri, der drives udenfor Kysten af Søndmør, ogsaa maatte kunne lønne sig udenfor Lofoten og Vesteraalen. Vesteraalseggen vil maaske være lettere at drive end Storeggen, idet der er kortere Udsejlads, gode Med paa Land, saaat man let kan tage op Fiskepladsen, og gode Havne i Nærheden.

I Tromsø blev Expeditionen liggende til den 14de Juli, Kjedlen rengjordes, Axelen i Indhivningsmaskinen omlagdes, der fyldtes Kul og Vand. Overlæge Hansen gik i Land, og Kjøbmand Friele embarkerede, men maatte atter flytte i Land efter et Par Dages Forløb, da han var saa uheldig at forvride sin Fod. Lieutenant Petersen flyttede ogsaa i Land, da han i flere Uger ikke havde befundet sig vel, og haabede ved et Ophold i Land at blive sat istand til senere at følge med Expeditionen paa Turen til Jan Mayen. Under Opholdet i Tromsø arbejdede Zoologerne med Skrabninger fra Baad, Dybvandsthermometrenes Nulpunkter undersøgtes, Kronometrenes Stand verificeredes og absolute magnetiske Iagttagelser erholdtes.

Da den første Halvdel af Juli Maaned allerede udløb, før Expeditionen kunde fortsætte sine Arbejder i Søen, besluttedes det først at tage under Arbejde Bankerne nordenfor Tromsø, og derpaa at foretage Rejsen til Jan Mayen, hvor man kunde vente at finde Havet mere isfrit i August Maaned.

Lørdag den 14de Juli besøgtes Kjosen i Ulfsfjorden og Kl. 2 Mandag Morgen gik Expeditionen herfra tilsøs nordover gjennem Fugløgabet. Der undersøgtes nu to Tversnit nordenfor Malangenfjord ved at tage 18 Lodskud, 3 Skraber, 1 Trawl og 3 Temperaturrækker. Ved disse Tversnit bestemtes ogsaa Vesteraalseggens nordre Ende. Under dette Arbejde var Vejret mindre gunstigt, vi havde østlig Kuling med adskillig Sø samt koldt Vejr og Taage, men ikke mere end at Arbejdet gik sin uforstyrrede Gang. Fredag den 20de kom vi atter tilbage til Tromsø, hvor baade Hr. Friele og Lieutenant Petersen kom ombord igjen, begge betydeligt restituerede.

Efterat Forsyningerne atter vare kompletterede, afgik Expeditionen igjen den 24de Juli, og med fuld Damp og alle Sejl i Træk for en frisk nordøstlig Vind sattes Kursen vestover. Efterat 680 Kvartmile var udsejlede, var paaværende Plads 70° 23′ N. Br. og 2° 30′ L. Ø. f. Gr., og her toges det første Lodskud paa 1760 Favne. Fra dette Sted loddedes med omtrent 48 Kvartmils Mellemrum videre vestover indtil Dybden begyndte at aftage til mindre end 1000 Favne, da Lodskuddene sattes tættere. Den 28de,

down to 1400, — a fall which, referring as it does to the sea-bed, must be regarded as rather rapid. The fish met with on the Vesteraals-Eg belonging to the same species as those frequenting the Stor-Eg, and moreover, the bottom in both localities being of a like nature and formation, there is every reason to believe that a fishery of the kind now flourishing off the coast of Søndmør might be successfully carried on off Lofoten and Vesteraalen. Nay, the Vesteraals-Eg will, perhaps, as regards facilities for fishing it, prove superior to the Stor-Eg: to begin with, the run from shore is considerably shorter; excellent landmarks, too, indicate the bearings of the fishing-grounds, and good harbours are within easy distance.

The "Voringen" remained at Tromsø till the 14th of July. During our stay, her boilers were cleaned and examined and the shaft of the donkey-engine relaid: here, too, she coaled and watered. Dr. Hansen left the ship, and Mr. Friele embarked, but had to go on shore again after a couple of days, having had the misfortune to sprain his ankle. Lieutenant Petersen, too, who for some weeks past had been indisposed, took a lodging in the town, in the hope that a short residence on shore would recruit his health, and enable him to accompany the Expedition to Jan Mayen. The work done at Tromsø comprised dredging from a boat, determining the freezing-points of the deep-sea thermometers, verifying the errors of the chronometers, and performing absolute magnetical determinations.

The first half of July expiring before the Expedition could resume its investigations at sea, we determined to explore first the banks north of Tromsø, and then proceed to Jan Mayen; besides, the sea surrounding that island would in all probability be less encumbered with ice in the month of August.

On Saturday the 14th of July we steamed to Kjosen in the Ulfsfjord; and from here, on Monday, at 2 a.m., the Expedition put to sea, steering northward through the Fugløgab. We now investigated two transverse sections north of the Malangenfjord, taking 18 deep-sea soundings, 3 hauls of the dredge, 1 cast of the trawl, and 3 serial temperatures. In these sections was also determined the northern extremity of the Vesteraals-Eg. For this exploratory work we had anything but favourable weather; it was cold and foggy, and blowing hard from the east, with rather a heavy sea; no break, however, occurred in the investigations. On Friday the 20th of July the Expedition again arrived at Tromsø, where we were joined by Mr. Friele and Lieutenant Petersen, both gentlemen much benefitted by their brief sojourn there.

After taking in a few additional stores, the Expedition once more put to sea, on the 24th of July, standing westward, under full steam, and every sail drawing in a fresh north-easterly breeze. When the distance run had reached 680 miles, the ship's position was lat. 70° 23′ N., long. 2° 30′ E. Here the first sounding was taken, in 1760 fathoms. From this point, steering westward as before, we sounded at regular intervals of about 48 miles, till the depth had gradually diminished to less than 1000

da Skibet efter Bestikket nærmede sig Land, hvilket dog paa Grund af Taagen ikke kunde sees, blev Dybden atter over 1200 Favne, senere 1060 Favne og derpaa 654 Favne. Ikke en halv Time senere fik vi gjennem Taagen Øje paa en af de stejle Isbræer paa Østsiden af Jan Mayen, og da Taagen en Stund efter lettede sig noget op, kom ogsaa Øens Nordspidse tilsyne. Hvor vi stoppede, var Dybden 144 Favne. Pladsen blev nu bestemt, idet vi blev liggende med Loddet i Bund, først Afstanden fra Land ved Ekkoet af et Kanonskud, der tydelig lod sig iagttage, og dernæst Retningen ved Pejlinger af de synlige Pynter i Nord og Syd.

Da Søen stod paa Østsiden af Jan Mayen, besluttedes at sejle omkring Øen til Vestsiden. Vi tog da Loddet ind og stod nordover langs Kysten med de mange Isbræer, men i det samme Øjeblik vi var tvers af Nordpynten, lagde Taagen sig atter ned paa Havet og tog bort al Udsigt. Der var imidlertid nu Intet til Hinder for at gaa omkring til Vestsiden. Vi styrede først Nord, derpaa Vest, saa Sydvest og endelig Sydost, medens Havoverfladens Temperatur maaltes hvert femte Minut. Den holdt sig jevnlig over 3°, og gik kun en Gang ned til 2°.3 C. Af Is var intet Spor. Da vi efter Bestikket nærmede os Vestkysten, loddedes nogle Gange indtil endelig Taagen løftede sig igjen, saaat Strandpartierne blev synlige. Vi kunde saaledes vælge vor Ankerplads, og Kl. 11 om Aftenen faldt Ankeret paa 20 Favne Vand i Marie-Muss Bugten, hvor der, uagtet hele Havet staar paa, var saa roligt som i en indelukket Havn.

Den følgende Dag var Havet ligesaa roligt, men Taagen skjulte fremdeles alt undtagen de lavere Partier, og laa som et Tæppe over vore Hoveder i omtrent et Par hundrede Meters Højde. Strax om Morgenen blev der gjort Landgang paa Stranden søndenfor "Fugleberget," et ejendommelig formet og farvet Fjeld. Levningerne af et gammelt Krater, der springer noget frem søndenfor den paa denne Side af Øen værende Lagune. Der var forskjellige Partier iland hele Dagen, som gjorde botaniske og geologiske Iagttagelser, tog Skitser og gik paa Jagt efter Søfugl og Polarræve. Af de sidste blev skudt 3 Stykker.

Den 30te Juli foretoges Skrabninger fra Baad i Marie-Muss Bugten, men da det begyndte at blæse en Bris af nordvestlig Vind, blev Brændingerne paa Stranden snart saa store, at man ikke kunde komme iland. Over Middag tiltog Vindens Styrke, og Kl. 5 Eftm. lettede vi for at gaa om paa den anden Side af Øen. Under Letningen kom Solen frem et Øjeblik, der blev maalt et Par Højder af den, og strax efter rev Vinden en Aabning i Taagen, saa vi første Gang fik se Beerenberg, hvis blændende hvide,

fathoms, when the soundings were set closer. On the 28th, when by dead reckoning the vessel was nearing land, which, however, we could not see owing to fog, the depth had again increased to upwards of 1200 fathoms; it then fell off, the two next soundings giving respectively 1060 and 654 fathoms. Scarce half an hour later we caught sight through the fog of one of the beetling glaciers on the eastern shore of Jan Mayen, and shortly after, the fog lifting a little, the northern extremity of the island rose in view. The depth where we stopped the engine was 144 fathoms. Lying to, with the lead on the bottom, the position of the vessel was now determined, — viz. by computing the distance of the land, from the echo following the discharge of a cannon, which could be distinctly observed, and then by taking the bearings of the promontories visible in the north and south.

With the wind then blowing, the sea broke on the eastern shore of Jan Mayen, and we determined, therefore, on steaming round to the west side of the island. Accordingly, we hauled in the lead, and stood northward, coursing along the coast, with its numerous glaciers; but, at the very moment we were abreast of the northern extremity of the island, the fog dropped like a curtain, cutting off every glimpse of Jan Mayen from our view. Meanwhile, there was nothing to prevent us from steaming on to the western shore. First we steered north, then west, then south-west, and finally south-east, recording every five minutes the temperature of the surface-water. This, with one exception, when it sank to 2°.3 C., was everywhere registered above 3° C. Ice there was none. So soon as our reckoning showed us to be nearing the west coast of the island, we sounded at intervals, till the fog at length rose, disclosing the lower parts of the island. We could now look about us, and at 11 p.m. let go our anchor in 20 fathoms, in Mary Muss Bay, which, notwithstanding its exposed situation, was then as smooth as a mill-pond.

On the following day the sea was equally calm, but the dense fog, stretching like a blanket about a couple of hundred metres above our heads, shut out from view, as on the previous afternoon, all but a low-lying strip of shore. Early in the morning we landed, south of the "Fugleberg," or breeding-cliff, a rock of singular hue and formation, the remains of an ancient crater, jutting forward to the south of the lagoon that lies on this side of the island. Several exploring parties passed the day on shore, doing botanical and geological work, sketching the scenery, and shooting sea-fowl and Polar foxes. The number of foxes killed was three.

On the 30th of July we dredged the bottom from a boat in Mary Muss Bay; but a breeze springing up from the north-west, there was soon too much surf on the shore to admit of landing. Shortly after noon the wind began to freshen, and at 5 p.m. we weighed anchor, deeming it best to run back to the opposite side of the island. Whilst the ship was getting under weigh, the sun came out a moment, enabling us to obtain a couple of altitudes; and immediately after, through a sudden rent in the fog, we caught

solbelyste Top mod den dybe blaa Himmel var et ligesaa gribende som pragtfuldt Syn. Under Gangen rundt Øens nordre Del til Rækved-Bugten bestemtes de forskjellige synlige Pynters og Isbræers Beliggenhed ved Hjelp af Pejlinger og Vinkelmaalinger med Sextant. Ved Midnat ankredes i den store Rækved-Bugt udenfor Lagunen paa 12 Favne Vand en god Kvartmil VSV. af Egøen.

Paa denne Ankerplads blev vi liggende den følgende Dag. Brændingen var for stor til, at vi kunde føre nogen Instrumenter iland. Skyteppet laa fremdeles over Beerenberg og over Sydlandets Højder, men Solen trængte oftere gjennem, saaat der fra Skibsborde kunde faaes en længere Række Solhøjder. Om Eftermiddagen, efter et frugtesløst Forsøg paa at komme iland, bestemtes ved Vinkelmaalinger Retninger og indbyrdes Afstande mellem flere af de fremtrædende Punkter paa Østsiden og Fugleberget paa Vestsiden, hvis Top kunde sees over Øens laveste Del. Samme Dag toges Skitser af de synlige Partier af Øen, og arbejdedes paa grundt Vand af Zoologerne.

Onsdag den 1ste August erholdtes atter nogle Solhøjder fra Ankerpladsen om Formiddagen. Skydækket begyndte at løse sig over Øens nordlige Del, men laa fremdeles tungt over den sydlige. Havets Tilstand var den samme, som Dagen før. Vi lettede og stod udover paa Havet, loddede, tog Temperaturrækker og skrabede paa den af sort Sand og Ler bestaaende Havbund. Imidlertid blev Beerenberg efterhaanden befriet for Taagehyllet, og om Eftermiddagen havde vi Fjeldet ganske klart i hele sin Udstrækning. Paa Havet havde vi ofte sterke Hvirvelvinde, og paa Land saa vi dem hvirvle Egøens løse Tufsand højt i Vejret, et skuffende Billede af en vulkansk Eruption. Om Aftenen ankredes udenfor Lagunen et Par Kvartmil i Sydvest for den forrige Ankerplads.

Den 2den August var Brændingerne fremdeles hinderlige for Landgang. Vi lettede om Formiddagen og stod østover, ved hvilken Lejlighed Beerenbergs Højde blev bestemt ved udsejlet Distance og Vinkelmaalinger. Derefter skrabedes og loddedes, idet vi atter gik østenom og nordenom Øen. Beerenberg tilhyllede sig atter i sit Taageslør, og vi havde seet den for sidste Gang. Allerede 7 Kvartmil i Nordøst for Nordøstkap fandtes 1040 Favne. Derefter oploddedes et Snit mod Vest og senere Nordvest, i hvilket vi fik 1000 Favnes Dyb i omtrent 28 Kvartmils Afstand fra Land. Der viste sig heller ikke her nogen Is paa Havet, men Luftens Temperatur gik om Natten ned til + 0°.1. Da vi allerede østenfor Jan Mayen havde fundet Kuldegrader i Havet i et saa ringe Dyb som 20 Favne, og saaledes var komne ind i den grønlandske Polarstrøm,

our first glimpse of Beerenberg, with his dazzling, snow-clad summit, standing boldly out against the deep-blue northern sky — a truly grand and imposing spectacle. On our course round the northern shores of the island to the Great Wood-Bay, we determined the position of the glaciers and headlands then visible, by compass bearings and observations with the sextant. At midnight we came to anchor in the Great Wood-Bay, off the lagoon, in 12 fathoms, upwards of a mile west-south-west of the Egg-crater.

We lay at our anchorage the whole of the following day. There was too much surf to attempt conveying any instruments ashore. The canopy of clouds still extended over Beerenberg and the heights in the southern part of the island, — though not so dense but that the sun could occasionally pierce it; and hence we succeeded from our position on board the ship in obtaining a series of altitudes. In the afternoon, having made a fruitless attempt to land, we determined by trignometrical observations the bearings of several of the salient points on the east coast, and their respective distances from the Fugleberg on the western shore, the summit of that cliff being visible above the lowest parts of the island. Mr. Schiertz, artist to the Expedition, made sketches of the scenery then in view, and our naturalists dredged in shallow water.

On the forenoon of Wednesday the 1st of August we could again take a few altitudes of the sun. There was now a rent here and there in the cover of cloud over the northern parts of the island; but over the southern it still hung heavily. As on the day before, there was a considerable swell. Weighing anchor, we stood out to sea, sounding, taking serial temperatures, and dredging the bottom, which consisted of black sand and clay. Meanwhile, Beerenberg had begun to emerge from under his misty shroud; and in the afternoon the giant stood forth in all his grandeur. Off the coast, fierce eddying gusts (whirlwinds) repeatedly swept the surface of the ocean; and on shore, as could be plainly seen from the deck of the vessel, they whirled high into the air the loose tufaceous sand of the Egg-crater, presenting a striking resemblance to a volcanic eruption. In the evening we anchored off the lagoon, a couple of miles south-west of our last anchoring-place.

On the 2nd of August the surf still prevented our landing. Getting under weigh in the forenoon, we stood eastward, our first work being to measure the altitude of Beerenberg, by computing from the distance run and trignometrical observations. We then dredged and sounded, again coursing east and north of the island. Beerenberg once more retired within his misty covering, and we had seen him for the last time. At no greater distance than 7 miles north-east of the north-eastern extremity of the island, the depth was 1040 fathoms. We then explored a section bearing west and north-west, in which the depth reached 1000 fathoms, about 28 miles from land. No ice was met with here, either in the sea; but the temperature of the atmosphere sank at night to + 0°.1. Having observed east of Jan Mayen at the trifling

havde vi ingen særlig Grund til at opsøge selve Isgrændsen, og sejlede derfor tilbage mod Jan Mayen, hvor vi om Morgenen den 3die August befandt os udenfor Marie-Muss Bugten. Vejret var meget taaget og Brændingerne forbød Landgang. Vi gik om Formiddagen langs Vestkysten sydvestover, tog enkelte Lodskud og Skitser, naar Taagen lettede. Ved Middag passeredes Sydkap og de syv Klipper, hvorpaa hele Jan Mayen forsvandt i Taagen. Der arbejdedes nu paa flere Stationer sydover til et Punkt omtrent midtvejs mellem Jan Mayen og Islands Banker (69° 2′ N. Br., 11° 26′ L. V. f. Gr.), hvor der var 1004 Favne. Her slukkedes af, og i stille og loj Bris drev vi med Polarstrømmen sydover, medens Fyrgangene rengjordes, hvilket Arbejde var færdigt om Eftermiddagen den 5te August, hvorefter Kursen sattes østover for at støde sammen med det før oparbejdede Snit fra Trænen. Under denne Del af Arbejdet fandtes vor største Dybde — 2005 Favne — paa 68° 21′ N. Br. og 2° 5′ L. V. f. Gr. Middag den 8de August naaedes det vestligste af de før tagne Lodskud, og den 10de om Morgenen passerede vi gjennem Moskenes-Strømmen, den berygtede Malstrøm, ind i Vestfjorden, der laa i det pragtfuldeste Vejr. Om Eftermiddagen toges omtrent 8 Kvartmil søndenfor Skraaven en Misvisnings- og Deviationsobservation, og om Aftenen tørnedes i Ørsnes. Den næste Dag toges to Skrabninger i Vestfjorden, og om Aftenen Kl. 11 ankom Expeditionen til Bodø.

Her blev nu Kjedlen ordentligt efterseet og Skibet rengjort udenbords. Samtidig toges magnetiske og astronomiske Observationer i Land. Onsdag den 15de August gik vi ind til Hopen, hvor vi fyldte en Del Vand, og gik derfra paa stille Vande gjennem Saltstrømmen ind i Skjerstadfjorden, hvor der blev taget 3 Lodskud, en Temperaturrække og 2 Skraber, hvoraf den ene strax indenfor Strømmen viste et særdeles rigt Dyreliv. Vi laa tilankers en Dag ved Rognan i Saltdalen, hvor vi fyldte det manglende af Vandbeholdningen. Lørdag den 18de August toges atter en Temperaturrække i Vestfjorden, hvorefter Kursen sattes sydover. Kl. $10^1/_2$ Form. den 23de August ankom Expeditionen til Bergen, hvor Desarmeringen strax paabegyndtes, og Skibet blev overleveret Rederiet færdig til Fragtfart paa den i Kontrakten stipulerede Dag, den 7de September.

Der blev dette Aar ialt taget 160 Lodskud, 27 Skraber, 9 Trawler og 37 Temperaturrækker. Expeditionen

depth of 20 fathoms a temperature below 0°, and thus struck the Greenland Polar current, we had no call to push on in search of the Ice-barrier itself, and accordingly steamed back to Jan Mayen, reaching that island, off Mary Muss Bay, on the morning of the 3rd of August. The weather was exceedingly foggy, and the surf forbade all thoughts of landing. During the forenoon we coursed along the western shore in a south-westerly direction, took a few soundings, and made sketches of the coast whenever the fog cleared off. By noon we had reached South Cape, after passing which and the Seven Cliffs Jan Mayen suddenly disappeared, the whole island having been swallowed up, as it were, by the fog. We now took a southward course, investigating at several stations, to a point about midway between Jan Mayen and the Iceland banks (lat. 69° 2′ N., long. 11° 26′ W.), where the depth was 1004 fathoms. Here, we had the engine-fires put out, preparatory to clearing the stoke-holes; and now in a dead calm, now before a light breeze, the "Vøringen" drifted south with the Polar current. On the afternoon of the 5th she was again under steam, standing east for the Trænen section, already explored. In this part of the ocean we found the greatest depth measured on the Expedition — 2005 fathoms, in lat. 68° 21′ N. and long. 2° 5′ W. On Monday the 8th of August, about noon, we reached the point at which the most westerly sounding had been taken, and on the morning of the 10th steamed through Moskenes Sound, with its whirlpool of dread repute — the celebrated Malstrom, into the Vestfjord, that lay extended before us, peacefully slumbering in the glorious summer weather. In the afternoon, about 8 miles south of Skraaven, observations were taken to determine the deviation of the compass, and in the evening we anchored at Ørsnes. On the following day the dredge was twice sent down in the Vestfjord, and in the evening the Expedition arrived at Bodø.

Here the boilers were carefully examined, and the outside of the vessel washed. Moreover, we took advantage of our stay at this place to take magnetical and astronomical observations on shore. On Wednesday the 15th of August the Expedition proceeded to Hopen, and took in there a supply of water, after which we steamed, with a slack tide, through Saltstrømmen Sound into the Skjerstadfjord. Here we took 3 soundings, 1 set of temperatures, and 2 hauls of the dredge, one of which, viz. that taken on entering the Sound, was uncommonly successful, bringing up a rich freight of animal life. We passed a day at Rognan in Saltdalen, to complete our supply of water. On Saturday the 28th of August, after taking another serial temperature in the Vestfjord, the Expedition stood south for Bergen, where we arrived on the 23rd of August, at 10 o'clock in the morning. After paying off the crew, the work of clearing the vessel and getting her ready for the freight-trade was at once commenced, and on the 7th of September, the day stipulated in the Contract, she was given up to her owners.

This year there were taken in all 160 soundings, 27 hauls of the dredge, 9 casts of the trawl, and 37 serial

havde hele denne Sommer et for de besøgte Farvande vistnok usædvanligt smukt Vejr, der ikke alene tillod, at der blev arbejdet paa saamange flere Stationer end den første Sommer, men Arbejdet paa hver enkelt Station blev udført med Ro og Lethed, og der var fuld Anledning for Zoologerne til strax at foretage de foreløbige og som oftest vigtigste Iagttagelser, hvilket det hyppigt det første Aar blev aldeles umuligt at udføre paa Grund af Skibets voldsomme Bevægelser.

temperatures. Throughout the entire season the weather continued remarkably fine for the high latitudes in which the Expedition had to cruise; and this fortunate circumstance admitted not only of our extending the exploratory work to a greater number of observing-stations than the year before, — at every single station, this could in consequence be accomplished with precision and comparative facility; moreover, ample opportunity was afforded the zoologists of instituting on ship-board their preliminary and, as a rule, most important observations, which, on the preceding cruise, had so frequently proved impossible, owing to the violent motion of the vessel.

1878.

Den for dette Aar vedtagne Plan, der ledsagedes af et Kart over de eventuelle Stationer, var saalydende:

Ved Expeditionens Rejser i 1876 og 1877 ere Undersøgelserne af det norske Hav i de Retninger, der ere Expeditionens Formaal, naaede til den 71de Breddegrad. Hvad der staar tilbage, er saaledes den nordenfor den nævnte Breddegrad liggende Del af det europæiske Ishav, der om Sommeren er navigabel uden Hindringer, foraarsagede ved Is.

Den Del af dette Hav, der ligger mellem Nordkap, Spidsbergen, Novaja-Semlja og Nord-Rusland — kaldet Østishavet, Novaja-Semlja-Havet eller det Murmanske Hav — vides ifølge Observationer fra Finmarkens Kyster og fra Havet søndenom og østenom Beeren-Eiland at være for hele den sydlige og vestlige Dels Vedkommende fyldt med Vand, der holder Varmegrader. Det synes at være fra dette Hav at Lodden, der giver Finmarken sit bekjendte Vaartorskfiske, kommer ind til den norske Kyst. Da Grændsen for begge disse Fiskearters Vandring antagelig er omtrent der, hvor det varme Vand ved Havbunden afløses af iskoldt Vand, maa det ansees for at være af stor Interesse at faa bestemt, i alle Fald i større Omrids, Beliggenheden af den Linie, der betegner Grændsen mellem det varme og det iskolde Vand ved Havbunden i Østishavet samt de øvrige fysiske og biologiske Forhold paa begge Sider af denne Grændse. Forholdene ere her i mange Henseender overensstemmende med dem paa Kystbankerne paa Norges Vestkyst, men vise ogsaa Forskjelligheder derfra og frembyde saaledes et Felt for Studiet af saavel Havstrømningernes Natur som af Dyrelivets Forhold, der er af høj Betydning for disses Forklaring i sin Almindelighed.

Til at lette denne Undersøgelse tjener for det første den Omstændighed, at Østishavet er forholdsvis grundt — de største Dybder naa ikke 300 Favne. Desuden er Nordgrændsen for det varme Vand ved Bunden paa en større

1878.

The Scheme approved for this year, to which had been appended a Diagram showing the position of each observing-station, ran as follows: —

As the result of its cruises in 1876 and 1877, the Expedition has investigated the Norwegian Sea in the several directions that had necessarily to be taken for the attainment of the object proposed, up to the 71st parallel of latitude. Hence, what remains to be explored is the tract of the Arctic Ocean in Europe stretching north of the said line, and which in the summer months may be navigated without impediment from ice.

The section of this ocean-basin lying between the North Cape, Spitzbergen, Novaja Zemlja, and Northern Russia — differently designated as the East Arctic Ocean, the Novaja Zemlja Sea, the Murman Sea, and the Barentz Sea — is known, from observations instituted on the coasts of Finmark and in the open sea south and east of Beeren Eiland, to be filled with water of a temperature above 0° throughout the southern and western tracts. It is from this sea, apparently, that the capelan, the little fish to which Finmark is indebted for her spring cod-fishery, repairs to the Norwegian coast. The boundary that marks the migratory distribution of these two fishes, lying, we have reason to believe, about where the warm and cold bottom-water meet, it is obviously of great importance to determine — if not in detail, at least broadly — the line bounding the warm and cold areas at the bottom of the East Arctic Ocean, together with the physical and biological conditions dominant on either side. The general conditions there have in many respects not a little in common with those of the coastal banks off the western shores of Norway; but, differing materially in some, they present, as regards the nature of ocean-currents and the conditions of animal life, a specially valuable field of elucidative research.

Exploratory work in this tract will be much facilitated by reason of the comparative shallowness of the East Arctic Ocean, — the greatest depths not even reaching 300 fathoms. Besides, the northern boundary of the warm

Strækning allerede bestemt, nemlig østenfor Beeren Eiland, og en ydre Grændse foreløbig kjendt mod Øst ved de talrige og udmerkede Observationer, som den østerrigske Polarfarer Løitn. Weyprecht har anstillet og velvilligen meddelte Professor Mohn til Afbenyttelse. Disse Omstændigheder tillade en saa vidt gaaende Orientering i Feltet, at man kan gjøre en Beregning over den Tid, Undersøgelserne ved Expeditionen antagelig ville komme til at tage. En saadan Beregning, hvis Resultat nedenfor skal meddeles, viser, at der for Tidens Skyld Intet er til Hinder mod at optage denne Undersøgelse af Østishavet inden Expeditionens Undersøgelseskreds.

bottom-water has been already determined for a considerable distance, viz. east of Beeren Eiland; and we are furnished, provisionally, with an extreme eastern limit in the many and excellent observations taken by the Austrian Arctic traveller, Lieutenant Weyprecht, and which he has kindly placed at the disposal of Professor Mohn. These data suffice to give some little familiarity with the salient features of the section, and hence afford a means of approximately computing the probable duration of the period required for the proposed investigations. A calculation has accordingly been made, and with such results that, as regards time, there will be nothing that need exclude a scientific investigation of the Barentz Sea from the exploratory work of the Expedition.

Ved de sidste Expeditioner af Professor Nordenskiöld er det kariske Havs fysiske og biologiske Forhold blevne undersøgte. Vor Expeditions Undersøgelse af Østishavet vil knytte Undersøgelserne fra det hele Atlanterhav til dem, der ere gjorte og forhaabentlig til Sommeren af Nordenskiöld blive gjorte ved Kysterne af det asiatiske Ishav og dem, der ere gjorte i endnu nordligere Egne af den østerrigsk-ungarske Polar-Expedition.

On the latest Swedish Expeditions, the physical and biological conditions of the Kara Sea were investigated by Professor Nordenskiöld. The exploration of the Murman Sea by the Norwegian Expedition will connect the investigations embracing the whole of the Atlantic with those that have been, and next summer, there is reason to believe, will be, carried out by Nordenskiöld in the Arctic Ocean off the coasts of Asia, and those achieved in still higher latitudes by the Austrio-Hungarian Polar Expedition.

I Forbindelse med Undersøgelserne af Østishavet er det ønskeligt at benytte Anledningen paa Rejsen langs Finmarkens Kyst til zoologiske Undersøgelser i nogle af de Fjorde, der hidtil ikke ere undersøgte af vore Zoologer, saasom Altenfjord, Porsangerfjord eller Laxefjord og Tanafjord. Endvidere er det af Vigtighed for de meterologiske Observationer, som udføres paa Expeditionen, at de nærmeste Stationer i Norge, med hvilke Observationerne fra Havet blive at sammenstille, inspiceres ved samme Lejlighed i Lighed med hvad der de foregaaende Aar har fundet Sted. Disse Stationer ere Alten (Bossekop) Gjesvær og Vardø, af hvilke i alle Fald den første og sidste ligge lige i den til de ovennævnte Undersøgelsers Udførelse førende Vej.

When coursing along the coast of Finmark to the Murman Sea, advantage shall be taken of the opportunity then afforded of prosecuting zoological work in divers of the fjords not yet investigated by our naturalists, for example the Altenfjord, the Porsanger or Laxefjord, and the Tanafjord. Moreover, it is important, as regards the meteorological observations of the Expedition, that the stations — at the nearest points on the Norwegian coast — with which the observations taken in the open sea will have to be compared, shall on that occasion be duly inspected, as on the two preceding cruises. The stations in question are Alten (Bossekop), Gjesvær, and Vardø, two of which, the first and the last, lie directly in the route of the Expedition to the aforesaid field of investigation.

Undersøgelserne af Havet mellem Nordkap, Jan Mayen og Spidsbergen antages at burde foretages paa samme Maade, som man tidligere er gaaet frem paa, nemlig ved Tversnit der opgaaes nogenlunde lodret mod Kysterne. Da Havbroen mellem Norge og Spidsbergen og Spidsbergens Vestkyst gaar i en mere nordlig og vestlig Retning end Norges Kyst ved Tromsø, blive Tversnittenes Retning at lægge mere langs Parallelcirklerne end tidligere. En Overgang heri kan naturligst ske ved at lægge et Par mindre Snit mellem Beeren-Eiland og Norge i Vinkel med Toppunkt ude i Havet omtrent midt imellem to større Tversnit.

For the exploration of the Sea extending between the North Cape, Jan Mayen, and Spitzbergen, the best system will, it is believed, be that previously adopted, viz. of laying transverse sections as nearly as may be perpendicular to the coast. The edge of the bank between Norway and Spitzbergen, as also the western shores of that island, extending more to the north and west than does the coast of Norway at Tromsø, the transverse sections will have to be given a position somewhat more concentric with the parallels of latitude than in the tracts previously explored. With this object in view, the most natural transition may be effected by laying at an angle, with the vertex seawards, a couple of smaller sections beween Beeren Eiland and Norway, about midway between two larger sections.

Indtil Beeren Eiland (75° N.) lægges de store Tversnit med samme indbyrdes Afstand som Snittene søndenfor fra 1877. Det sydligste af de nye Snit er Fortsættelsen vestover af det nordligste i 1877 oparbejdede Snit. Vest-

As far north as Beeren Eiland (lat. 75°), the large transverse sections will have to lie at the same distance each from each as those explored south of that locality on last year's cruise (1877). The most southerly of the new sec-

grændsen for disse Tversnit er Østgrændsen for Grønlandsisen, eller om denne skulde være usædvanlig langt tilbagetrukket mod Vest, en Linje, der tillader ved Lodskuddene at opnaa en sikker Kundskab om Havbundens Form i det Store og et nøjagtigt Studium af det her antagelig værende dyriske Protoplasma, som fandtes i 1877 ved Jan Mayen. Vestenfor Spidsbergen er Bundens Form i det Store taget nogenlunde kjendt efter de svenske Expeditioners Lodninger. Men da paa den Tid disse foretoges (1868) endnu intet paalideligt Dybvandsthermometer havdes og Skrabninger paa store Dyb med store Apparater ikke vare komne igang, vil det for vor Expeditions Øjemed være nødvendigt at gjennemgaa det hele Felt systematisk. Da Afstanden mellem Spidsbergens Vestkyst og Grønlandsisen aftager raskt mod Nord, blive Tversnittene her efterhaanden kortere og kunne derfor samtlige lægges helt over den nævnte Afstand med en indbyrdes Afstand af en god Breddegrad.

Paa Bankerne sættes Lodskud saa tæt, at disses Afheld mod Dybet bliver bestemt paa en utvetydig Maade. Ude i det store Ishavsdyb vil en Meridiangrad (60 Kvartmil) antagelig være en passende Afstand mellem Lodskuddene i samme Tversnit.

En Gjenstand for speciel Undersøgelse bliver den varme Atlanterhavs Strøms Løb og Udstrækning mellem Beeren Eiland og Spidsbergen. Denne Undersøgelse, der fordrer Rækker af tættere Lodskud med Temperaturrækker, lover at blive af overordentlig stor Betydning for Havstrømmenes Theori, da den varme Strøm her flyder nordover mellem 2 sydovergaaende Polarstrømme, Grønlandshavets i Vest og Østspidsbergen — Beeren Eiland's mod Øst.

Dersom Isforholdene tillade det, udstrækkes Undersøgelserne til Spidsbergens Nordkyst. Antagelig er her Polarstrømmen alene raadende og dermed en passende Grændse sat for Expeditionens Arbejder mod Nord.

At udstrække Rejsen saa langt ind i Polarstrømmen, som Isforholdene tillade, er af Vigtighed for Undersøgelsen af det i 1877 ved Jan Mayen fundne Protoplasma.

Undersøgelserne antages at burde deles i 3 Afdelinger, mellem hvilke anløbes nærmeste norsk Havn (Hammerfest) for Udrustning med Kul, Vand, Proviant etc. Turen til Øst-Ishavet antages at burde foretages først, da Isen her antagelig tidligere trækker sig tilbage end i Grønlandshavet. Turen til Spidsbergen lægges til August Maaned, der er den bedste Aarstid paa disse Kanter. Turen vesterud til Grønlandshavet nordenfor Jan Mayen bliver saaledes den 2den i Rækken.

tions will extend westward from the most northerly section investigated the year before. The western limit for these sections will coincide with the eastern boundary of the Greenland ice-barrier, or, in the event of that barrier having receded unusually far west, with a line allowing the contour of the sea-bed on the Greenland side to be broadly determined, and offering ample opportunity for a detailed study of the animal protoplasma met with in 1877 off the island of Jan Mayen, and believed to occcur also in this region. West of Spitzbergen, the contour of the bottom was broadly determined by soundings taken on the Swedish Expeditions. No trustworthy deep-sea thermometer having however at that time been devised (1868), nor dredgings essayed at great depths with apparatus of proportionate dimensions, the whole of the tract will need to be gone over anew and systematically investigated. The distance between the west coast of Spitzbergen and the Greenland ice-barrier rapidly diminishing towards the north, the transverse sections here will get gradually shorter, and may accordingly be laid right across, at intervals slightly exceeding one degree of latitude.

On the banks, the soundings shall be taken with sufficient frequence to admit of clearly determining the seaward incline. In the great Arctic basin, intervals of 60 miles, or one meridional degree, will, it is believed, be a suitable distance at which to sound in one and the same section.

A subject for special investigation will be the flow and extent of the warm Atlantic current between Beeren Eiland and Spitzbergen. The solution of the problem therein involved, which calls for series of closer soundings, together with serial temperatures, cannot but furnish highly important data bearing directly on the theory of ocean currents, the warm Atlantic water here flowing northwards between two southward-setting Polar currents, — a western through the Greenland Sea, and an eastern passing along the shores of East Spitzbergen and Beeren Eiland.

Provided the further course of the vessel be unobstructed by ice, the Expedition will extend its investigations to the North Coast of Spitzbergen. In this region, probably, the Polar current alone prevails, and may, therefore, be taken as a proper boundary for the northern field of exploratory research.

By pushing on as far as practicable into the Polar current, i. e. till ice shall bar farther progress, much valuable material may be collected for prosecuting the investigation of the protoplasma found in 1877 off the island of Jan Mayen.

The exploratory work to be done on each cruise should, it is opined, embrace three intervals, or periods, the Expedition making, so soon as the investigations allotted to each shall have been completed, for the nearest Norwegian port (Hammerfest), to refit the vessel, taking in there a supply of coal, water, provisions, &c. The Murman Sea should, it is believed, be the first region explored, the ice there most probably breaking up somewhat earlier in the season than is the case with that of the Greenland Sea. The trip to Spitzbergen will be deferred till August, gener-

Expeditionen antages at afgaa fra Bergen i Midten af Juni til Tromsø. Forsaavidt Rejsen sker gjennem Vestfjorden, kunde Lejligheden benyttes til at tage en Temperaturrække i det dybeste af Vestfjorden udenfor Tranø, hvor de nye Dybvandsthermometre kunde prøves. Turen til Tromsø antages at kræve 4 Døgn. I Tromsø standses for at tage ombord en Mand, der medfølger Expeditionen som Kjendtmand for Finmarkens Kyst, Beeren Eiland og Spidsbergen. Derpaa gaar man ind til Alten, hvor den meteorologiske Station inspiceres, og Skrabning (Trawl) udføres i Altenfjorden. Herfra til Hammerfest, hvor Expeditionen indtager Forsyninger for Øst-Ishavsturen. Magnetiske Observationer til Bestemmelse af Misvisningen og Kompassets Deviation foretages i Altenfjord eller ved Hammerfest.

Fra Hammerfest sejles til Porsangerfjorden, hvor der loddes, tages Temperaturrækker og skrabes. Herfra, om Vejret (Taage) ikke er til Hinder, ind i Tanafjorden, hvor de samme Arbejder udføres. Derfra til Vardø, hvor den meteorologiske Station inspiceres.

Fra Vardø styres (omkring 27de Juni) først østover, derpaa nordover til Beeren Eilands Parallel og derpaa vestover, og Linjen for 0° ved Havbunden bestemmes. Ere Omstændighederne gunstige, forsøges Landgang paa Beeren Eiland. Herfra opsejles 2 Tversnit over Banken mellem Beeren Eiland og Norge for at bestemme dens Afheld mod Ishavsdybet, og derpaa sejles til Hammerfest, idet et Par Stationer lægges paa Vejen. Med en Fart af 6 Mil i Vagten, 16 Loddestationer (15 med Temperaturrække, 13 med Skrabe (Trawl)) vil Turen fra Vardø til Hammerfest (efter den Tid som Erfaringen fra 1877 har vist at der medgaar til de forskjellige Arbejder paa forskjelligt Dyb) tage 11 til 12 Døgn. I Hammerfest gjøres klar til 2den Tur vestover. Afgangen derfra kan sættes til omkring den 11te til 12te Juli.

2den Tur beregnes med 6 Knobs Fart, 18 Stationer (17 Temperaturrækker, hvoraf mange ganske korte i Polarstrømmen, 6 Skraber paa Banken, 2 Skraber paa stort Dyb — Lodning, Skrabe og Temperaturrække à 17 Timer) til $12^1/_2$ Døgn. Paa Udrejsen fra Hammerfest undersøges Temperaturforholdene i Dybet omkring Station 201 fra 1877, hvor der viste sig et paafaldende anomalt Forhold.

ally the finest month in the year in those latitudes. Hence, the run westward and subsequent investigation of the Greenland Sea north of Jan Mayen, will occupy the second of the three intervals, or periods, planned in this Scheme of Work.

By the middle of June the Expedition will, if possible leave Bergen for Tromsø. Should the route selected lead through the Vestfjord, a series of temperatures might be taken in the deepest parts of the fjord, off Tranø, and the new deep-sea thermometers tested. Four days will probably be sufficient for the passage north to Tromsø. At this port the Expedition will take on board a pilot for the coast of Finmark, Beeren Eiland, and Spitzbergen. The next place on the route is Alten, where the Meteorological Station will be inspected, and the fjord dredged and trawled. From here the Expedition courses on to Hammerfest, at which port stores will have to be shipped for the exploratory tour to the Murman Sea. Magnetical observations to determine the deviation of the compass shall be taken either at Hammerfest or in the Altenfjord.

From Hammerfest the course runs on to the Porsangerfjord, where soundings and serial temperatures will be taken, and the dredge and trawl worked. From this point, weather permitting (it is frequently foggy hereabouts), the Expedition will steam on to the Tanafjord, and there prosecute similar exploratory work. The next place to be touched at is Vardø, where the Meteorological Station will be inspected.

From Vardø the Expedition will first stand eastward (about the 27th of June), then northward for the Beeren Eiland parallel of latitude, and then westward, determining by the way the boundary of the glacial bottom-area. If anyway practicable, the Scientific Staff will land on Beeren Eiland. From this point the Expedition shall explore a couple of transverse sections on the bank between Beeren Eiland and Norway, with the object of determining its incline towards the depths of the Arctic Ocean, and then run back to Hammerfest, working at one or two stations by the way. Steaming at the rate of 6 miles an hour, and with 16 sounding-stations, at 15 of which serial temperatures will have to be taken and at 13 dredging and trawling-work done, the passage back to Hammerfest *viâ* Vardø (judging from last year's experience as to the time required for the different investigations at various depths) can be made in 11 or 12 days. At Hammerfest the vessel has to be got ready for the second of the cruises westward, the departure of the Expedition being fixed for about the 11th or 12th of July.

The speed of the vessel being supposed to average 6 knots, this second cruise will, with 18 stations (17 serial temperatures — many of those in the Polar current being however quite short — 6 hauls of the dredge on the bank, and 2 at great depths [sounding, dredging, and taking temperatures estimated to occupy 17 hours]), take 12 days and a half. On the run out from Hammerfest, the Expedition shall investigate the thermal conditions prevailing in deep water round Station 201, where, on last

Efter færdig Ekvipering i Hammerfest til Spidsbergensturen (antagelig omkring den 29de Juli) sejles til Farvandet mellem Beeren Eiland og Spidsbergen, hvilket antages at kunne undersøges tilstrækkeligt ved 3 Tversnit. Fra Sydkap sejles vestover til Grønlandsisen, nordover langs Isgrændsen og derpaa østover mod Mundingen af Isfjorden. Det næste Tversnit tænkes lagt vestover fra Kingsbay til Isgrændsen og det sidste store Tversnit lidt nordenfor 80° Bredde. Den her nævnte Del af Turen med 27 Stationer (25 Temperaturrækker, hvoraf flere smaa, 11 Skrabninger) samt Tilbagerejse til Hammerfest beregnes med 6 Mils Fart til $13^1/_2$ Døgn.

Paa Optur søges Arbejdet paa Søen først fremmet med den Hurtighed, som Undersøgelsernes Nøjagtighed kræver og Vejrforholdene tillade. Ere de sidste gunstige, anvendes de følgende Dage til mere specielle Undersøgelser paa Spidsbergens Banker, i dens Fjorde, i Land. Under tidligere indtræffende ugunstige Vejrforhold, tages de sidstnævnte Arbejder i Mellemtiden, om muligt, og Arbejderne i Søen under de gunstigere Perioder. Tilbagerejsen tiltrædes omkring den 24de August og gaar til Hammerfest eller (nærmere) til Tromsø, hvor den kjendte Mand sættes af. Herfra til Bergen, hvor Expeditionens derboende Deltagere gaa fra Borde, hvorpaa Rejsen fortsættes til Christiania og Horten, hvor Desarmeringen finder Sted, og Fartøjet gjøres istand til Overleverelse til Rederiet.

De videnskabelige Arbejder udføres væsentlig paa samme Maade som i 1877.

Ved Lodningerne og Temperaturrækkerne søges erholdt saamange fuldstændige Sammenligninger mellem de forskjellige Slags Dybvandsthermometre, som Omstændighederne tillade. En nøjagtig Undersøgelse af de ved de to første Togter benyttede Dybvandsthermometre ved Sammenligning med nyere Sorter er af største Vigtighed for den nøjagtige Bestemmelse af Temperaturen i Dybet paa de af Expeditionen i 1876 og 77 besøgte Strækninger. Bundprøve tages ved hvert Lodskud og opbevares. Temperaturrækkerne tages saa tæt, at en utvetydig Kundskab erholdes om Varmefordelingen i Dybet. I Polarstrømmen kunne de fleste Temperaturrækker indskrænkes til de øverste Vandlag (til — 1°), idet et Par fuldstændige Rækker tages gjennem hele Dybet til Constatering af Temperaturforholdene. Strømmaalinger forsøges. Ligeledes tages om muligt ved hvert Lodskud og paa enkelte Stationer, hvor det ansees ønskeligt, i intermediære Dybder Vandprøver til Bestemmelse af specifisk Vægt og chemisk Undersøgelse. Et Piezometer bør medfølge hvert Lodskud, dels som Control for Dybden dels til Bestemmelse af Piezometrets Constanter.

year's cruise, a singular anomaly of temperature was observed.

Having refitted at Hammerfest (by about the 29th of July) for the excursion to Spitzbergen, the Expedition shall at once proceed to the tract between Beeren Eiland and Spitzbergen, for investigating which three transverse sections will probably prove sufficient. From South Cape the course will lie westward to the Greenland ice, then northward along the ice-barrier, and then eastward for the mouth of the Ice-Sound. The next transverse section should, it is opined, stretch westward from King's Bay to the ice-barrier, and the last of the large transverse sections lie north of the 80th parallel of latitude. This third part of the entire cruise, with 27 Stations (25 serial temperatures, several of them short, and 11 hauls of the dredge), including the run back to Hammerfest, is calculated, with a speed of 6 knots, to take 13 days and a half.

On the passage out, all deep-sea work shall be done first, as expeditiously as may prove consistent with accurate investigation and the state of the weather. Provided the latter be favourable, some few days may then be devoted to more special investigations on the banks of Spitzbergen, in the fjords of the island, and on shore. Bad weather supervening, the exploration of the depths shall be broken off, to be resumed under more favourable circumstances, and the work on the banks prosecuted, if possible, in the interim. On the homeward passage — to commence about the 24th of August — the Expedition will make for Hammerfest, or possibly a nearer point, Tromsø, where the pilot will quit the ship. From here the homeward course runs straight to Bergen, where the members of the Scientific Staff resident in that city disembark, after which the vessel will proceed to Christiania and Horten. At Horten she will be paid off, and put in order previous to being given up to her owners in Bergen.

The scientific work of the Expedition to be prosecuted essentially as in 1877.

When taking soundings and serial temperatures, the various kinds of deep-sea thermometers shall be compared together as closely and as frequently as circumstances may admit of. A rigorous testing of the deep-sea thermometers employed on the two first cruises, by comparing them with those of a later construction, is of the utmost importance as regards the true determination of the temperature in the deeper strata of the ocean-tracts then visited by the Expedition. A sample of the bottom shall be brought up at every sounding, and preserved for subsequent examination. The serial temperatures shall be taken sufficiently close to afford a clear insight into the thermal conditions throughout the ocean-depths. In the Polar current, most of the serial temperatures may be confined to the upper strata (to — 1°), two complete series being taken throughout the entire depth, to substantiate the nature of the thermal conditions. Observations are, if possible, to be taken for ascertaining the rate and direction of currents. Moreover, with every sounding, and at some stations from intermediate depths, a sample of the sea-water shall, if

Arbejde med Skrabe, Trawl, Svabere og Overfladenet foretages paa de Stationer, hvor saadanne ansees nødvendige for Studiet af Dyrelivet i de forskjellige Dybder, undersøiske Klimater og Bundarter.

De chemiske Arbejder, inclusive Bestemmelsen af Havvandets specifiske Vægt udføres i det væsentlige som i 1877.

Magnetiske Observationer søges udført i Søen, navnlig Misvisnings-Observationer. Absolute Bestemmelser af de jordmagnetiske Elementer søges gjort paa Land paa Spidsbergen, Beeren Eiland og i Norge. Saavidt muligt paa Steder, hvorfra der tidligere haves saadanne.

Geologiske og botaniske Iagttagelser udføres efter Lejlighed paa de Steder, som Expeditionen anløber. Ligesaa astronomiske Stedbestemmelser, topografiske og hydrografiske Undersøgelser.

De meteorologiske Iagttagelser ombord udføres som i 1877.

Ved de Lejligheder, Expeditionen passerer Beeren Eiland, forsøges, om Omstændighederne maatte være gunstige, Landgang der til Udførelse af astronomiske, geografiske, geologiske, zoologiske, botaniske, hydrografiske Undersøgelser.

Paa Spidsbergen foretages lignende Undersøgelser paa de Steder, hvor Expeditionen kommer til at anløbe — hvilke Steder blive at bestemme efter de Fordringer, som Arbejderne i Søen stille. Specielt haves Opmærksomheden rettet paa Undersøgelse af Fiskerierne ved Spidsbergens Kyst og i dens Fjorde, paa jordmagnetiske og hydrografiske Undersøgelser.

Som Følge af, at Expeditionen for dette Aar var besluttet forlagt 14 Dage senere end de foregaaende Aars, indførtes de nødvendige Forandringer i Kontrakten om Lejen af Skibet, og dette overtoges først den 1ste Maj. Indredningsarbejderne udførtes ved Brunchorst & Dekkes Værft aldeles som det foregaaende Aar, uden Forandring hverken i Apteringer eller i Apparaternes Placering.

Den 11te Juni hejstes Kommandoen og Mandskabet paamønstredes. Da Premierlieutenant Petersen havde frasagt sig Posten som Næstcommanderende paa Grund af Sygdom, blev denne Stilling overtaget af Skibsfører Grieg, medens en tredie Styrmand forhyredes, for om muligt at overtage noget af Trediecommanderendes Tjeneste. Den 13de Juni kom Professor Sars og Kemikerne Tornøe og Schmelck ombord, og den 14de halede vi ud fra Værftet

possible, be collected, for determining the specific gravity, and for chemical examination. A piezometer will have to be sent down with every sounding, partly as a means of controlling the depth, and partly to determine the constants of the piezometer.

Exploratory work with the dredge, trawl, surface-net, and swabs, will be prosecuted at all stations where it affords opportunity of investigating the forms of animal life in the various depths, as also submarine climatic conditions, and the materials of the sea-bottom.

The chemical work of the Expedition, including determinations of specific gravity, to be done essentially as on last year's cruise.

Magnetical observations shall, if possible, be taken at sea, in particular those for obtaining the variation of the compass, and absolute determinations ashore, on Spitzbergen, Beeren Eiland, and in Norway, if practicable at points from which such observations already exist.

Geological and botanical work will be prosecuted in suitable localities; likewise astronomical observations of latitude and longitude, together with topographical and hydrographical investigations.

The meteorological observations to be taken essentially as on last year's cruise.

When passing Beeren Eiland, attempt shall, on each occasion, if practicable, be made to land there, with the object of prosecuting astronomical, geographical, geological, zoological, botanical, hydrographical investigations.

On Spitzbergen, too, like investigations shall be undertaken in localities visited by the Expedition, the number and positions of the localities depending on the time required for the exploration in the open sea. Attention is specially directed to the fisheries off the coasts of Spitzbergen and in the fjords of the island, as also to the importance of magnetic and hydrographical observations.

The departure of the Expedition this year having been fixed to take place a fortnight later than on the two preceding cruises, a clause to that effect, modifying the terms originally agreed upon, was introduced into the Contract for the hire of the vessel; and accordingly she was not taken in charge till the 1st of May. This year, too, the ship was fitted out by Messrs. Brunchorst & Dekke, without change either as regards the general arrangement or the placing of the apparatus.

On the 11th of June I hoisted my pennant, and the crew came on board. Lieutenant Petersen, R.N., having from ill-health had to resign his post as first-lieutenant, Mr. Grieg, captain in the merchant-navy, was appointed to succeed him, and a third mate engaged to assist the first-lieutenant in the discharge of his duties. On the 13th of June Professor Sars embarked, along with Mr. Tornøe and Mr. Schmelck; and on the 14th we hauled out

og gik Prøvetur, under hvilken Loggemaskinen prøvedes og Kompassets Deviation undersøgtes. Lordag den 15de kom D'Hrr. Mohn, Danielssen, Friele og Schiertz ombord og Kl. $4^{3}/_{4}$ samme Dags Eftermiddag afgik Expeditionen fra Bergen og styrede nordover langs Leden.

Mandag den 17de Juni, efter Afgangen fra Børosund ved Throndhjemsleden havde vi det Uheld, at Skibet, omtrent tvers af Nordpynten af Fjeldvær, skurede over en Boe, og jeg saa, at en Del af Straakjølen gik tabt. Skibet blev ikke staaende, og heller ikke lækt, saa at der var stor Sandsynlighed for, at det ikke havde faaet nogen væsentlig Skade. Da der ikke existerer nyere, detaljerede Karter over denne Del af Kysten, var jeg her afskaaret fra Lejlighed til at kunne kontrollere Lodsen. Et Par Timer efter var vi saa heldige at træffe Havnevæsenets Dampskib "Nicolay," hvor Havnedirectør Roll med sin Dykker var ombord, og strax var villig til at yde fornøden Bistand. Begge Skibe gik da ind i Hopen-Fjord, hvor Dykkeren tre Gange var nede og undersøgte Vøringens Bund. Da han erklærede, at Skibet ingen anden Skade havde faaet, end det før nævnte Tab af en Del af Straakjølen, fortsattes Rejsen om Natten nordover. Under hele vor Rejse mærkedes ingensinde nogensomhelst Ulempe efter Stødningen, men ved Doksætningen om Høsten viste det sig, at selve Kjølen ogsaa for en Del var beskadiget, saaledes at Veritas-Besigtigelsen fordrede et Stykke ny Kjøl indsat.

Onsdag den 19de Juli toges en Temperaturrække og en Skrabe i Vestfjorden og Kl. 11 Form. den 20de ankom vi til Tromsø, hvor Kjendtmand Petter Bjorvik kom ombord. Denne Mand var gjennem velvillig Assistance af Hr. Toldkasserer Pettersen bleven engageret til at følge Expeditionen som Lods paa Finmarken og Spidsbergen. Kl. 4 samme Dags Eftermiddag afgik Expeditionen til Alten-Fjord, hvor der den 21de toges to Temperaturrækker, Skrabe og Trawl, medens Hr. Friele arbejdede langs Landet fra Baad og Professor Mohn inspicerede Altens meteorologiske Station. Kl. $5^{1}/_{2}$ Form. den 22de Juni ankredes i Hammerfest, hvor vi fyldte Vand og blev liggende Søndagen over. Kl. 2 Form. Mandag den 24de afgik vi fra Hammerfest, og arbejdede de følgende Dage i Porsanger-Fjord og i Tana-Fjord. Udenfor Baads-Fjord toges Misvisnings- og Deviations-Observation og den 25de Kl. $11^{1}/_{2}$ Eftm. ankom Expeditionen til Vardø. Efterat her var taget magnetiske og astronomiske Observationer og den meteorologiske Station inspiceret, gik vi tilsøs om Morgenen den 27de for efter Planen at begynde med Undersøgelserne i Øst-Ishavet.

from the wharf to take a trial-trip, during which the log-apparatus was tested and the deviation of the compass determined. On Saturday the 15th of June Professor Mohn, Dr. Danielssen, Mr. Friele, and Mr. Schiertz came on board; and on the afternoon of that day, at 4.45 p.m., the Expedition left Bergen, proceeding northward by the inshore route.

On Monday the 17th of June, shortly after our departure from Børosund, a place on the inshore route to Throndhjem, the vessel chanced unfortunately to touch a sunken rock, and I saw part of the false keel carried away. Meanwhile, as the ship neither stuck fast nor sprang a leak, there was good reason to believe she could not have sustained any material damage. New, detailed charts for this part of the coast having not yet been constructed, I was unable to check the pilot. A couple of hours or so after our misadventure, we had the good fortune to fall in with the steamer "Nicolay," belonging to the Harbour Works; and Mr. Roll, the director, who happened to be on board and had with him his diving-assistant, at once volunteered assistance. Both vessels now steamed into the Hopen Fjord; and here Mr. Roll's diver went down three times in succession to examine the "Voringen"'s bottom. His report, however, being to the effect that, beyond the aforesaid loss of part of her false keel, the ship had sustained no damage whatever, we resolved to continue the voyage, and after night-fall pursued our course northward. During the whole cruise no detrimental effects were found to result from the accident; but on docking the vessel in the autumn after our return, it seemed that the true keel had suffered to some extent too; indeed the Surveyor to the "Veritas" insisted on having a new piece put in.

On Wednesday the 19th of July a serial temperature and a haul of the dredge were taken in the Vestfjord; and on the forenoon of the 20th, at 11 a.m., we arrived at Tromsø, where a pilot, Petter Bjørvik by name, came on board. This man had been engaged by Mr. Pettersen, receiver of customs, to act as pilot to the Expedition for the coasts of Finmark and Spitzbergen. The same day, at 4 o'clock in the afternoon, the Expedition proceeded to the Alten Fjord, where, on the 21st, two serial temperatures were taken, together with a haul of the deep-sea apparatus, both dredge and trawl, Mr. Friele working the while along the shore from a boat, and Professor Mohn being occupied with inspecting the Meteorological Station at Alten. On the forenoon of the 22nd the Expedition arrived at Hammerfest, where we took in a supply of water, and spent the following day (Sunday) at anchor. On Monday the 24th of June, at 2 a.m., the Expedition left Hammerfest, and devoted the next few days to exploratory work in the Porsanger and Tana Fjords. Off the mouth of the fjord observations were taken to determine the variation and deviation of the compass, and on the 25th, at 11.30 p.m., the Expedition reached Vardo. After a series of magnetical and astronomical observations had been taken, and the Meteorological Station inspected, on the morning

Kursen sattes først i øst-nord-østlig Retning og samme Dag toges Trawl og Skrabe, samt tre Lodskud, men om Aftenen begyndte det at kule paa, og om Natten maatte vi lægge paa Vejret og blev liggende for Storm af VNV., Regn og noget Snedrev samt høj Sø til næste Dags Aften den 28de, da vi loddede og atter styrede øst-nord-østover. Der arbejdedes nu under stadig Kuling, surt og koldt Vejr først nordover til Beeren-Eilands Parallelcirkel og derefter vestover, indtil vi om Aftenen den 3die Juli fik Beeren Eiland i Sigte, og vi saa da den første Drivis, dog kun enkelte Flager. Om Formiddagen den 4de Juli ankrede vi under Beeren-Eiland udenfor den saakaldte Sydhavn, og landsatte den til den hollandske Expedition med Skonnerten "De Willem Barendsz" fra Bergen medtagne Post, der nedgravedes i Nærheden af Russestuen og merkedes paa den af den hollandske Konsul opgivne Maade. Samtidig blev der skudt en Del Fugle og foretaget botaniske og geologiske Indsamlinger. Højden af Mount Misery bestemtes ved Vinkelmaalinger. Om Eftermiddagen afgik vi fra Beeren-Eiland og arbejdede sydvestover for at bestemme Affaldet af Banken mod Vest. Kl. $5^1/_2$ Form. den 6te Juli fik vi 1024 Favne paa 73° 6′ N. Br. og 11° 56′ L. Ø. f. Gr., hvorefter Kursen sattes øst-syd-østlig for at bestemme Affaldet paa en sydligere Bredde, og Kl. 2 Eftermiddag Mandag den 8de Juli ankom vi til Hammerfest.

Fra Tirsdag Morgen til Fredag Aften benyttedes Tiden til at skrubbe Skibsbunden, fylde Kul og Vand, rengjøre Kjedlen og efterse Maskinen, samt til at tage magnetiske og astronomiske Observationer, der udførtes paa Fuglenes i Nærheden af Gradmaalingsstøtten.

Kl. 6 Formiddag den 13de Juli afgik vi i godt Vejr paa den anden Tur og satte Kursen vestover. Om Eftermiddagen toges en Misvisningsobservation med Azimuther Kompasset rundt. Med vest-nord-vestlig Kurs naaedes den næste Dags Middag vort nordligste Punkt fra det foregaaende Aar, hvor der toges Lodskud og Bundtemperatur med 4 Thermometre af forskjellig Konstruktion. Herfra sejledes videre mod Vest-Nord-Vest, under jevnt Arbejde med Lodskud, Temperaturrækker og Trawl, indtil vi Onsdag Aften den 17de mødte de første Flager af den grønlandske Vest-Is og Kl. $10^1/_4$ maatte vi stoppe for tættere Drivis. Vi var da paa 73° 10′ N. Br. og 3° 22′ L. V. f. Gr., og havde saaledes mødt Isen paa en ikke lidet østligere Længde end paaregnet. Vejret var blevet koldt og taaget med en stiv Kuling af nordvestlig Vind. Efterat der var taget en Temperaturrække i Nærheden af Isen, sattes Kursen nordøstover og senere nordover langs Isen, der snart tabtes af

of the 27th of June we steamed out of the harbour, on the morning of the 27th of June, *en route* for the Barentz Sea, where, according to the Scheme of Work, the Expedition was now to commence investigations.

Our course lay first east-north-east, and the same day we dredged and trawled and took three soundings; but in the evening it came on to blow, and in the night we lay to, and rode out a gale from the west-north-west, with rain and snow and a heavy sea, till the evening of the following day, the 28th; we were then able to sound, after which we steamed on again, steering as before east-north-east. We now pushed on, in cold and boisterous weather, first northward as for as the Beeren Eiland parallel of latitude, and then westward till, on the evening of the 3rd of July, that island hove in sight, and we passed the first drift-ice, — however only a few isolated floes. On the forenoon of the 4th we anchored off South Harbour, as it is called, and sent ashore the letter-box we had brought from Bergen for the Dutch Expedition with the schooner "De Willem Barendsz;" this we buried near the Russian Hut, after marking it in the manner indicated by the Dutch consul. While some of the party were thus engaged, others roamed about, shooting birds and collecting botanical and geological specimens. The altitude of Mount Misery was determined by trignometrical observations. In the afternoon we left Beeren Eiland, steering south-west to determine the slope of the bank in a westerly direction. On the 6th of July, at 5.30 a.m., we sounded in 1024 fathoms, lat. 73° 6′ N., long. 11° 56′ E., after which the course of the vessel was changed to east-south-east, with the object of determining the slope farther south; and on Monday the 8th of July, at 2 o'clock in the afternoon, the Expedition arrived at Hammerfest.

From Tuesday morning til Friday evening the time was occupied with scrubbing the ship's bottom, taking in coal and water, cleaning the boilers, and examining the engine, as also with taking magnetical and astronomical observations, at Fuglenes, near by the column indicating the terminus of the Russian-Swedish-Norwegian arc of meridian.

On the 13th of July, at 6 a.m., we left Hammerfest, in fine weather, standing west on the second excursion of the cruise. In the afternoon observations were taken to determine the variation of the compass. Steaming west-north-west, by next day at noon we had reached the most northerly point of last year's cruise. Here soundings were taken, and the bottom-temperature registered with 4 thermometers of different construction. From this point we continued to steer west-north-west, taking soundings and serial temperatures and working the trawl, till on the evening of Wednesday the 17th of July we reached the first floes of the Greenland ice, and at 10.15 p.m. the engines had to be stopped, owing to the closer packing of the drift-ice. We were then in lat. 73° 10′ N. and long. 3° 22′ W., having struck the ice considerably farther east than anticipated. The weather had now turned cold and foggy, with a stiff breeze from the north-west. After taking a series

Sigte, men hvis Nærhed tilkjendegaves af den lave Temperatur. Fremdeles herskede ogsaa Taage, Kuling og Sø. Fredag Morgen den 19de havde vi naaet 75° 16′ N. Br. 0° 54′ L. V. f. Gr. og fik her dette Aars dybeste Lodskud, med 1985 eng. Favne, hvorefter Kursen sattes østover langs den 75de Breddegrad. Ved fortsatte Lodninger, Temperaturrækker og Trawlinger bestemtes paa Østgaaende, ligesom før paa Vestgaaende, den omtrentlige Grændse mellem Polarstrømmen og det varme Vand i Havets østlige Del. Ligeledes bestemtes Opgangen af Banken noget nordligere end Beeren Eiland, og Undersøgelserne fortsattes videre østover, indtil vi den 23de Juli befandt os paa 74° 57′ N. Br. og 19° 52′ L. Ø. f. Gr., hvor vi havde 21 Favne Vand med en Bundtemperatur af + 0°.2. Her toges en Skrabe, hvorpaa vi, under tiltagende Nordenvindskuling, holdt ned mod Beeren Eiland og derefter ostenom Øen til dens Sydside. Søen var her allerede betydelig, saa det var forbundet med Vanskeligheder at gjøre Landgang. Vi saa imidlertid, at vort Flag var borte, og sluttede deraf, at Hollænderne havde været der og fundet Posten, hvilket viste sig at være rigtigt, efter de Efterretninger fra "Willem Barendtsz" som vi modtog fra Vardø ved vor Ankomst til Hammerfest. Den 24de lænsede vi med Storm af NNV., høj Sø, svære Slingringer og tilsidst Regntykke sydover mod Hammerfest. Kl. 10 om Aftenen fik vi et Øjeblik Kjending af Fruholm og Ingø tvers om Styrbord og Kl. 4 Formiddag den 25de kom vi i god Behold til Ankers i Hammerfest. Under Indsejlingen, da det var temmelig mørkt paa Grund af det tætte Regn, opstod Spørgsmaalet om at ankre, før vi kom til Hammerfest. Havde Nordhavs-Expeditionen gjort dette i Maasø, vilde den paa det nævnte Sted have stødt sammen med "Vega"-Expeditionen under Nordenskiöld og Palander, der laa her for at oppebie gunstigere Vejr. Da vi bestemte os til at gaa til Hammerfest med en Gang, passerede de to Expeditioner hverandre paa nogle faa Mils Afstand uden at vide det.

Fredag og Lørdag anvendtes til Fyldning af Vand og Kul, og Mandag den 29de Juli Kl. 6 Eftermiddag forlod vi atter Hammerfest for at udføre vor tredie Tur, idet vi til Afsked saluterede Byen med 4 Skud. Kursen sattes mod Beeren Eiland, som vi, efterat have taget 3 Lodskud og en Trawl undervejs, naaede Onsdag den 31te. Da vi ogsaa kom op under Øen, faldt Barometret 1^{mm} i Timen, ligesom Luften saa saa truende ud, at vi besluttede at se Vejret an i nogen Tid, og efter et Par Timers Forløb havde vi ogsaa fuld Storm. Da vi under disse Omstændigheder ikke kunde arbejde med Lodning og Skrabning, men godt nytte Tiden til Arbejder under Læ, naar Skibet var nogenlunde roligt, holdt vi det gaaende under Øens Østside, hvor Søen var nogenlunde rolig. Thorsdag Aften toges en Del Misvisnings-

of temperatures in close proximity to the ice, we stood on our course, steering first north-east and then north, along the ice, which was soon lost sight of, though the low temperature announced its comparative nearness. Fog, wind, and sea also continued to prevail. On the morning of Friday the 19th of July we had reached a point in lat. 75° 16′ N. long 0° 54′ W. Here a sounding was taken (1985 fathoms), the deepest on this year's cruise, after which we steamed eastward along the 75th parallel of latitude. By a continuous succession of soundings, serial temperatures, and trawlings, the boundary between the Polar current and the warm flow in the eastern section of the Sea was now on our passage east, as before on our passage west, approximately determined. We likewise determined the rise of the bank somewhat farther north than Beeren Eiland, and then continued investigating eastward till on the 23rd of July we found ourselves in lat. 74° 57′, long. 19° 52′ E., with a depth of 21 fathoms and a bottom-temperature of + 0°.2. Here we took a haul of the dredge, and then bore down, in a rising gale from the north, on Beeren Eiland, making for the south coast along its eastern shores. The sea here already running high, considerable difficulty would have been experienced in landing. Meanwhile, we could see that our flag was gone, and of course concluded that the Dutch explorers had found their letter-box, which, on our arrival at Hammerfest, proved to have been correct, a communication received there from the "Willem Barendtz" *viâ* Vardø apprizing us of the fact. On the 24th we stood south for Hammerfest, scudding before the wind in a gale from the north-north-west, with the ship rolling heavily, and a rainy mist coming on. About 10 p.m. we caught a glimpse of Fruholm and Ingø on the starboard beam, and next morning (July 25th), at 4 o'clock, dropped our anchor in Hammerfest harbour. When steaming up the fjord, it was rather dark, from the drizzly rain, and the question arose, whether it would not be best to anchor, for instance at Maasø, before proceeding to Hammerfest. Had this been done, the Norwegian North-Atlantic Expedition would have fallen in with the "Vega" Expedition, under the direction of Nordenskiöld and Palander, then lying at anchor here till the weather should moderate. As it was, the two Expeditions passed within a few miles of each other without knowing it.

Two days (Friday and Saturday) were spent in getting the ship ready for sea (watering, coaling, &c.), and on Monday the 29th of July, at 6 p.m., we again left Hammerfest, on the third excursion of the cruise, firing a salute of 4 guns in honour of the town, as we steamed out of the harbour. The Expedition stood straight for Beeren Eiland, which it reached on Wednesday the 31st of July. On the passage across, 3 soundings had been taken and one cast of the trawl. As we were nearing the land, the barometer began to fall, 1^{mm} an hour; the sky, too, wearing a threatening appearance, we resolved to wait and see how the weather would turn out. And it was well we did, for an hour or two after it blew a gale. Deep-sea operations, such as sounding and dredging, were now, of

og Deviations-Observationer med Skibet, og da Vejret nu havde bedaget sig noget, gjorde Kl. 9½ D'Hrr. Mohn, Sars, Friele, Tornoe, Schmelck og Grieg Landgang ved Engelsk-Elven og foretog en Exkursion langs Østkysten i nordlig Retning. Imidlertid kom Taagen igjen og blev tættere efterhaanden, og Kl. 3 maatte jeg ankre op nær Land for ikke i den stærke Strøm at komme bort fra Landingspladsen eller stode paa Grund. Kl. 4 Fredag Morgen kom Exkursionspartiet ombord igjen, medbringende Fugle, Forsteninger og Planter. Efterat Baaden var ophejst, forsogte vi at fiske, og det viste sig, at der stod en Mængde Torsk under Øen. Fra Kl. 5 til 7 droges 200 Stykker. Stormen vedvarede fremdeles og først den næste Dags Morgen bedagede den, saa at vi atter kunde sætte Kurs nordover. Samme Dags Eftermiddag naaede vi Station paa 75° 32′ N. Br. og 17° 50′ L. Ø. f. Gr., hvor vi fik 123 Favne og tog en Trawl. Vi oparbejdede nu Partiet til Spidsbergen i to mindre Tversnit, først et mod Vest-Nord-Vest, og derpaa et mod Øst-Nord-Øst og naaede ved Enden af dette Sydkap paa Spidsbergen Mandag den 5te August om Eftermiddagen. Da det blæste en frisk Bris af Nordvest, gik vi i Læ paa Østsiden af Sydkap, hvor vi om Aftenen tog en fuldstændig Misvisningsobservation, og gik om Natten op under den store Isbræ, der skyder som et mægtigt Forbjerg ud i Havet. Om Morgenen den 6te skrabede vi i Storfjorden paa 146 Favne, omsejlede Sydkap og satte derefter Kursen mod Vest. Med Undtagelse af enkelte Isflag, der drev sydover og enkelte mindre Isbjerge i den ostlige Horizont var Storfjorden isfri indenfor vor Synskreds. Den 6te og 7de August arbejdede vi paa Snittet vestover og kom i godt Vejr Kl. 9 Eftermiddag den 8de atter under Isen paa 76° 26′ N. Br. og 0° 29′ L. V. f. Gr., hvor vi fik 1686 Favnes Dyb. Trawlen blev sat ud, og der arbejdedes med den hele Natten, men den maa sandsynligvis være bleven fyldt med Rullestene, da Accumulatoren angav en ellers uforklarlig svær Vægt paa Touget, da Indhivningen begyndte. Uagtet al anvendt Forsigtighed sprang Touget, efterat der var hivet ind 3 Timer, Kl. 10 den næste Dags Formiddag. Sprængningen foregik ved en Spleds, der allerede var 3 Torn inde paa Spillet, og 2160 Favne Toug samt Apparater gik tabt. Vejret var usædvanligt smukt og før vi gik videre, toges en fuldstændig Misvisnings-Observation. Vi styrede derefter nordøstover mellem Isflagene, der nu vare komne rundt om os, og som i det klare Solskin og med sine fantastiske Former var et baade interessant og smukt Syn. Om Eftermiddagen kom vi atter ud af Isen og styrede nu mere nordlig Kurs, saaledes at vi Kl. 3 Formiddag den 10de vare paa 77° 50′ N. Br. og 0° 9′ L. V. f. Gr., hvor vi loddede 1640 Favne. Herfra sattes Kursen østover. Kl. 7 samme Dags Eftermiddag fik vi 1333 Favne, og da nyt Skrabetoug imidlertid var bleven sammenspledset og ny Trawl gjort istand, sattes denne ud. Kl. 9½ næste Formiddag fik vi den hjem med rig Fangst af Dyr og deriblandt Fiske, men Bommen var brækket af paa Midten, og der var en stor Sten paa en Mands Loft i den. Ved det næste Lodskud, der toges om Eftermiddagen, fandt vi

course, out of the question; but as work below could still be done when the motion of the vessel was not too violent, we kept her going, under lee of the land, along the eastern shore, where the sea continued comparatively tranquil. On Thursday evening observations were made to determine the variation and deviation of the compass; and the weather having now begun to moderate, Professors Mohn and Sars, Mr. Friele, Mr. Tornoe, Mr. Schmelck, and Captain Grieg succeeded in landing, at 9.30 p.m., close to the English River, and made an excursion along the east coast in a northerly direction. Meanwhile the fog came on again, getting gradually denser; and at 3 a.m. I had to anchor close in shore, for fear of drifting away from the landing-place, or running aground, in the strong current. On Friday morning, at 4 a.m., the exploring party returned, bringing with them specimens of birds, fossils, and plants. After hoisting up the boat, we passed an hour or two fishing, and found that cod were abundant off that part of the island, our catch from 5 a.m. to 7 a.m. amounting to as many as ten score. It was still blowing hard, and another day had yet to elapse ere the weather became sufficiently moderate to admit of our again pursuing a northward course. On the afternoon of the same day we reached a station in lat. 75° 32′ N., long. 17° 50′ E., where we sounded in 123 fathoms, and took a cast of the trawl. We now explored the tract stretching from that point to Spitzbergen, by means of two smaller transverse sections, one (the first) extending west-north-west, and the other east-north-east, and reached at the end of the latter South Cape, the southern extremity of Spitzbergen, on the afternoon of Monday the 5th of August. As it was blowing fresh from the north-west, we ran in shore east of South Cape, where, during the course of the evening, a complete observation was taken for determining the variation of the compass, and after night-fall we steamed up under the lee of the great glacier that juts out into the sea like a gigantic promontory. On the morning of the 6th we dredged in the Storfjord, at a depth of 146 fathoms, doubled South Cape, and then stood out to sea, steering west. Saving a few isolated floes drifting southward, and several smaller icebergs on the verge of the eastern horizon, the Storfjord was wholly unencumbered with ice, as far as the eye could reach. This and the following day (the 7th) were devoted to exploring the section westward, and on the 8th, at 9 p.m., with the weather fine, we again reached the ice, at a point in lat. 76° 26′ N., long. 0° 29′ W., where we found a depth of 1686 fathoms. The trawl was put over and worked throughout the whole of the night, but probably had got a freight of boulders, the accumulator indicating an otherwise unaccountable strain on the line immediately we began to heave. On the following day, at 10 a.m., the rope parted, in spite of every precaution taken to prevent it, after three hours' continuous hauling. The rupture occurred in a splice, which had already passed 3 turns on the drums, the apparatus consequently carrying away with 2160 fathoms of rope. The weather was magnificent, and before proceeding on our course, we took a complete observation

Dybden at være 1343 Favne. Dette Lodskud har den særegne Interesse og Betydning, at den Svenske Expedition med "Sofia" under Nordenskiöld og von Otter i 1868 fandt en Dybde af 1350 Favne, altsaa kun 7 Favne mere end vi, paa et Punkt der ligger kun 2 Kvartmile længere Vest end vor Station. Resultatet af Lodningen blev derfor imødeseet med en vis Spænding, der maatte være bevirket ved Betragtningen af vore to foregaaende Lodskud, men med den udmerkede Overensstemmelse fulgte Forvisningen om den svenske Expeditions talrige Dyb-Lodskuds Sikkerhed og store Betydning for det Endemaal, som vor Expedition var ude for at søge fremmet. Vi arbejdede nu videre i Retning mod Isfjordens Munding, bestemte Bankens Affald mod Ishavsdybet, og gik derpaa nordover og nordvestover. Sø og Vind var meget hinderlige, saa vi kun gjorde ringe Fart. Om Morgenen Onsdag den 14de August fik vi atter Is i Sigte. Vi var da nær den 80de Breddegrad. Efterat have loddet og trawlet her og længere øst lidt nordenfor 80° Bredde, gik vi om Morgenen den 15de ind til Norskøerne ved Spidsbergens Nordvest-Kyst.

Sundet mellem Norskøerne er en god Ankerplads, men Isflag drev stadig gjennem det med det stærke Tidvand, og Aftenen før vi kom ind, havde et stort Isflag brukket Kjettingerne og taget 3 af de her liggende 5 Fangstfartøjer med sig ud af Sundet. Der var stor Fiskerigdom, saaledes at 3 Baade med 2 Mand i hver i Løbet af et Døgn kunde fiske og virke 2200 Torsk. De havde blot 20 Minutters Udroning og fiskede paa 16 Favne Vand. Paa Grund af Flueaat (Limaciner) havde Fisken imidlertid her, ligesom ved Beeren Eiland, en meget ubehagelig Smag, der imidlertid skal forsvinde, naar Fisken saltes og klippes.

Medens "Vøringen" laa ved Norskøerne, blev Bunden skrubbet, og der indtoges en Del Ballast, hvortil der lige i Stranden var Anledning til at tage Sten. Skibet

to determine the variation of the compass. Then, standing north-east, we steamed on between the floes, which by this time were floating round the vessel, and in the bright sunshine, with their thousand fantastic shapes, afforded a striking and beautiful sight. In the afternoon we again got clear of the ice, and now taking a more northerly course, had by the 10th, at 3 a.m., reached a point in lat. 77° 50′ N. long. 0° 9′ W., where the depth was found to be 1640 fathoms. We now steered east, and on the same day, at 7 p.m., sounded in 1333 fathoms. A new dredge-rope having meanwhile been spliced, and other trawling-gear prepared, the apparatus was sent down. It came up next morning, at about half-past 9 o'clock, bringing a rich freight of marine animals, among which were a few fishes, but with the boom broken through the middle, and a big stone, as much as a man could lift, enclosed in the bag. In the afternoon we sounded again, and now found the depth to be 1343 fathoms. To this sounding attaches special interest and importance, since the Swedish Expedition despatched with the "Sofia" in 1868, under the direction of Nordenskiöld and von Otter, found a depth of 1350 fathoms — only 7 fathoms more than we measured here — at a point but two miles farther west of our station. The result of the sounding had been awaited with some little excitement after recording the two foregoing depths, and the satisfaction felt at the very close agreement was accompanied by the assurance of the trustworthiness distinguishing the deep-sea soundings taken on the Swedish Expedition, and of their great value as adjuncts in working out the object which the Norwegian Expedition had been despatched to attain. We now explored farther, in the direction of the Ice Sound, determined the slope of the bank towards the depths of the Arctic Ocean, and then stood north and north-west. But the weather was boisterous — wind and sea — and we made but little progress. On the morning of Wednesday the 14th of August we again came in sight of ice, near the 80th parallel of latitude. After sounding and trawling both at this point and farther east, a little to the north of 80°, we proceeded on the morning of the 15th to the Norway Islands, on the north-western coast of Spitzbergen.

In the sound between the Norway Islands there is good anchorage, but floes kept drifting through it with the strong tidal current, and the evening before a large floe, after breaking the cables, had carried 3 of the 5 fishing-vessels that lay at anchor here out of the sound. The place abounded in fish; 3 boats — 2 men to each — could catch and cure in twenty-four hours as many as 2200 cod. The row out took only 20 minutes, and the depth on the fishing-ground did not exceed 16 fathoms. The fish, however, like those on the shores of Beeren Eiland, being infested with parasitic animals *(Limacinæ)*, have a rather disagreeable taste; but this they are said to lose on being salted and dried.

Whilst the "Vøringen" lay at anchor at the Norway Islands, her bottom was scrubbed, and extra ballast taken in, the beach supplying stones in plenty. The ship had

var nemlig blevet noget let paa Vandet, navnlig trængte Agterenden til at komme noget dybere. I Løbet af disse Dage gjordes Exkursioner til Landet indenfor Norskøerne.

Kl. 4 Fredag Eftermiddag den 16de afgik vi atter fra Norskøerne, tog et Lodskud med Temperaturrække udenfor Hakluyt Head, Spidsbergens Nordvestpynt, og sejlede derpaa ned igjennem Smeerenberg-Sundet, østenom Amsterdam-Øen og Dansk-Øen, og ud gjennem Syd-Gat, efter det af Beechey og Franklin i 1818 optagne Kart, hvorefter vi Kl. $12^1/_2$ om Natten ankrede i Magdalena Bay indenfor Halvøen med Begravelsespladsen. Baade i Smeerenberg og i Magdalena Bay er Dalene fyldte med store Isbræer, der gaar lige i Søen, og de fra disse løsbrukne Isstykker flyder om i Sundene og Bugterne. Kl. 9 om Aftenen den 17de loddede og trawlede vi i Magdalena Bay, i hvis inderste Del vi fandt den laveste Temperatur i Søen paa hele Expeditionen, nemlig -2^0 C., ved Bunden paa 61 Favnes Dyb, medens Dyrelivet sammesteds var meget rigt, ja selv Fiske kom op i Trawlen. Fra Magdalena Bay styrede vi mod Sydvest udenom Prince Charles Foreland. Den 18de tog vi 4 Lodskud og en Trawl, og den 19de var vi om Morgenen i Isfjordens Munding, hvor der loddedes, toges Temperaturrække og trawledes. Kl. $2^1/_2$ Efterm. samme Dag gik Expeditionen til Ankers i Advent Bay paa Is-Fjordens Sydside. Landet her gjør en Undtagelse fra det ovenfor beskrevne Spidsbergenske Islandskab, idet Dalene her er fri for Isbræer. Jeg gik strax igang med at optage et Kart over denne af Spidsbergensfarere meget besøgte Bugt, og medens en Del af Medlemmerne var paa en Udflugt op i Landet, arbejdede jeg hermed, assisteret af Professor Mohn, der maalte Grundlinie, enkelte Horizontalvinkler og Solhøjder til Polhøjde- og Tidsbestemmelse, samt Skibsfører Grieg, der udførte Lodninger. Selv maalte jeg de fleste Horizontalvinkler, tog Azimutbestemmelsen, Lodskud og tegnede Kartet. Da de til Kartets Konstruktion nødvendige Observationer var udførte, lettede vi den 22de om Aftenen, tog en Trawl i Mundingen af Bugten, og styrede ud af Isfjorden. Det var Meningen den næste Dag at anløbe Bell-Sund, men det blev tyk Taage og Kursen sattes da hjem mod Norge. Kl. 12 om Natten mellem den 23de og 24de August toges sidste Lodskud og Temperaturrække, og Mandag Middag den 26de August ankredes i Tromsø, hvor vi strax gik i Gang med at fylde Kul og rengjøre Kjedlen. Vi havde da været under Damp uafbrudt i 30 Døgn, idet vi ikke slukkede af under Opholdet i Advent Bay paa Grund af den lave Temperatur, der gjorde Opvarmning af Arbejdsrummet nødvendigt.

Kl. 2 om Morgenen den 29de August afgik vi fra Tromsø og ankom Kl. $10^1/_4$ Form. den 4de September til Bergen.

got too high on the water, more especially her sternpart. During our stay here excursions were made to the mainland.

On Friday the 16th, at 4 o'clock in the afternoon, we again left the Norway Islands, took a sounding, along with a serial temperature, off Hakluyt Head, the northwestern extremity of Spitzbergen, and then steamed on through Smeerenberg Sound, east of Amsterdam Island and Danish Island, and out through South Gat, steering by the chart Beechey and Franklin constructed in 1818, after which we proceeded to Magdalena Bay, where the ship dropped her anchor, at 12.30 a.m., east of the peninsula with the burial-ground. Both at Smeerenberg and Magdalena Bay the valleys are filled up with glaciers, projecting into the sea; and fragments of dislocated ice float about in the sounds and bays. At 9 o'clock on the evening of the 17th we sounded and trawled in Magdalena Bay, where, in its inner part, was found the lowest temperature registered on the Expedition, viz. -2^0 C., at a bottom-depth of 61 fathoms. This spot was characterised by a rich variety of animal life, — nay even fishes came up in the trawl. From Magdalena Bay we steered south-west, rounding Prince Charles Foreland. On the 18th we took 4 soundings and a cast of the trawl, and on the morning of the 19th had reached the entrance to Ice Sound, where we sounded, took serial temperatures, and trawled. At half-past two, on the afternoon of the same day, the Expedition anchored in Advent Bay on the south shore of the Ice Sound. The land here forms an exception to the icy region of Spitzbergen described above, no glaciers encumbering the vallies. I immediately prepared to draw up a chart of this bay, so much visited by sealing and fishing vessels, and while part of the Scientific Staff were away on an excursion into the country, continued this work, with assistance from Professor Mohn, who measured the base, some of the horizontal angles and altitudes for determining latitude and time, and from Captain Grieg, who took soundings. Most of the horizontal angles I measured myself; I made, too, azimuth observations, took soundings, and drew the chart. After all the observations required for the construction of the chart had been taken, we weighed anchor, on the evening of the 22nd, took a cast of the trawl at the entrance to the bay, and steered out of Ice Sound. Our intention had been on, the following day to touch at Bell-Sound; but a thick fog coming on, we stood direct for Norway. At midnight on the 23rd of August the last sounding and serial temperature were taken, and on Monday the 26th, about 12 o'clock at noon, the Expedition reached Tromsø, where we at once commenced taking in water and cleaning the boilers. The vessel had been under steam for 30 successive days, the engine-fires having been kept burning during our stay at Advent Bay, in order to heat the work-rooms, which the low temperature prevailing in that locality rendered necessary.

On the 29th of August, at 2 o'clock in the morning, the Expedition left Tromsø, and on the forenoon of the

hvor D'Hrr. Danielssen, Friele, Tornoe og Schiertz debarkerede. Den nu overflødige Del af Besætningen afmonstredes og endel af de Skibet tilhørende Sager bragtes ombord, ligesom Laanegods afleveredes til Bergens Værft. Lordag Morgen den 7de afgik vi fra Bergen og ankom Kl. 4 Eftermiddag den 9de til Kristiania, hvor D'Hrr. Mohn, Sars og Schmelck gik iland. Næste Dags Middag den 10de September afgik jeg med Skibet til Horten, hvor Desarmeringen strax paabegyndtes. Den 20de var alle Sager bragt iland og Skibet klart til Aflevering med Undtagelse af Donkeykjedlen, der skulde tages ombord i Bergen. Kl. $5^1/_4$ Formiddag den 21de gik „Vøringen" fra Horten og ankom til Bergen den 23de.

Der var i 1878 ialt taget 117 Lodskud, 57 Temperaturrækker, 15 Skraber og 24 Trawler, samt, foruden de magnetiske Observationer i Land ved Hammerfest og Vardø, tillige 6 fuldstændige Misvisningsobservationer paa Søen, hvilke paa Grund af Observationsstedernes geografiske Beliggenhed er af megen Interesse.

Det i den oprindelige Plan angivne Farvand mellem Norge, Færøerne, Jan Mayen og Spidsbergen var saaledes befaret og Expeditionens Undersøgelsesrejser lykkelig tilendebragte i den for samme fastsatte Tid.

Den gode Forstaaelse mellem Expeditionens Medlemmer vedvarede uden Forstyrrelse lige til det Sidste. Sluttelig skal det ogsaa med Taknemmelighed bemærkes, at Expeditionen overalt blev mødt med den største Velvilje. Baade Amtmand Finsen paa Færøerne og Landshøvding Finsen paa Island, ligesom ogsaa Bergens, Kristiansunds, Namsos', Bodøs, Tromsøs og Hammerfests Borgere foranstaltede Festligheder i Anledning af Expeditionens Nærværelse og gjorde Alt, for at Opholdet paa de respective Steder skulde blive saa behageligt som muligt.

4th of September, at half-past ten o'clock, we arrived at Bergen, where Dr. Danielssen, Mr. Friele, Mr. Tornøe, and Mr. Schiertz disembarked. Part of the crew, viz. the now superfluous hands, were paid off, divers effects belonging to the ship brought on board, and borrowed gear returned to the Bergen Navy Yard. On the morning of Saturday the 7th of September we left Bergen, and on the 9th, at 4 o'clock in the afternoon, reached Christiania, where Professors Mohn and Sars and Mr. Schmelck went ashore. At noon on the following day I took the vessel to Horten. By the 20th, the ship had been cleared of everything belonging to the Expedition and got ready for her owners. On the 21st, at a quarter past five in the morning, the "Vøringen" left Horten, and arrived at Bergen on the 23rd.

On the third cruise of the Expedition, in 1878, there were taken in all 117 soundings, 57 serial temperatures, 15 hauls of the dredge, and 24 casts of the trawl, together — exclusive of the magnetical observations on shore at Hammerfest and Vardø — with 6 complete observations at sea for determining the variation of the compass, which, from the geographical position of the observing-points possess very considerable interest.

The tract of ocean embraced in the original Scheme, viz. that between Norway, the Færoe Islands, Jan Mayen, and Spitzbergen, had thus been investigated, and the exploring cruises of the Expedition happily terminated within the period appointed.

Nothing arose to cloud the friendly spirit prevailing among the members of the Scientific Staff. Nor must I, in conclusion, omit to record our debt of gratitude for the eager hospitality and ready assistance we everywhere received. Both the chief magistrate of the Færoe Islands, Amtmand Finsen, and the governor of Iceland, Landshøvding Finsen, had festivities arranged in honour of the Expedition, as did also the people of Bergen, Kristiansund, Namsos, Bodø, Tromsø, and Hammerfest, leaving nothing undone that might in any way tend to enhance the pleasure of our stay.

Til Expeditionens Udrustning og Drift har Storthinget bevilget følgende Summer:

i 1875	. . . . .	20,000 Spd.	=	80,000 Kroner.
i 1876	. . . . .	14,500 —	=	58,000
i 1877	. . . . .	28,327 —	=	113,308
	Tilsammen	62,827 Spd.	=	251,308 Kroner.

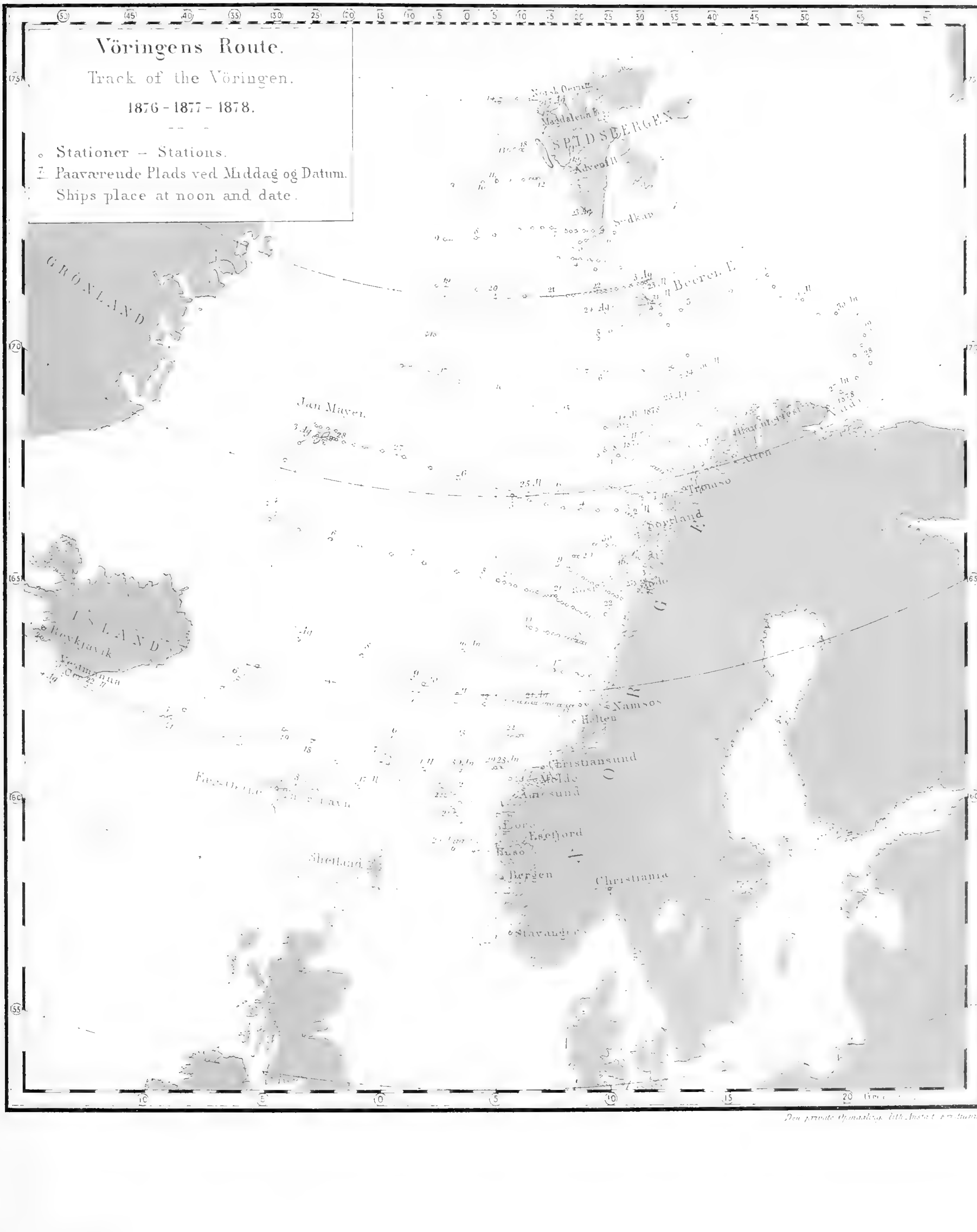
Efterat Apparater, Tougverk m. m., der var anskaffet til Expeditionen, blev realiseret ved Bortsælgelse, bliver den Sum, som Expeditionen har kostet ca. 249,000 Kroner. Heri medregnes ikke de Summer, som Storthinget siden 1879 hvert Aar har bevilget til Bearbejdelse af det indsamlede Materiale og til Udgivelse af nærværende Generalberetning.

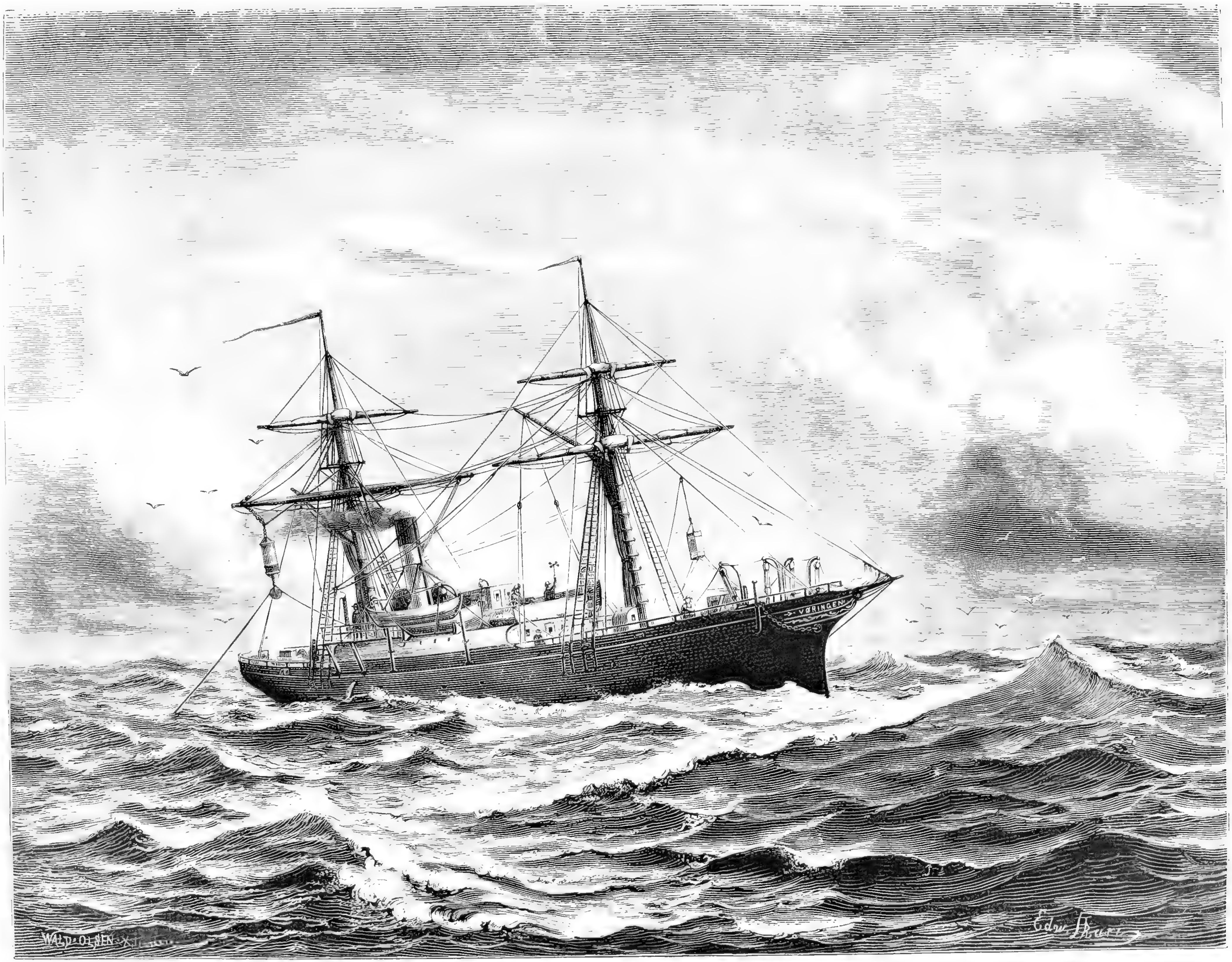
For the equipment and current expenses of the Expedition the Storthing has granted the following sums: —

In 1875	. . . . . .	Spd. 20,000	=	Kr. 80,000.
In 1876	. . . . . .	— 14,500	=	— 58,000.
In 1877	. . . . . .	— 28,327	=	— 113,308.
	Total . . .	Spd. 62,827	=	Kr. 251,308.

After deducting the proceeds arising from the sale of apparatus, cordage &c., provided for the Expedition, the nett amount expended will be about Kr. 249,000. This does not include the annual grants made by the Storthing since 1879 for working up the materials collected and publishing the present Report.

Norske Nordhavs-Expedition. C. Wille. Expeditionens Historie





VØRINGEN.

DEN NORSKE NORDHAVS-EXPEDITION

1876—1878.

APPARATERNE OG DERES BRUG

AF

C. WILLE,
KAPTEJN I MARINEN.

MED ET TITELBILLEDE OG 21 TRÆSNIT.

CHRISTIANIA.
GRØNDAHL & SØNS BOGTRYKKERI.
1882.

THE NORWEGIAN NORTH-ATLANTIC EXPEDITION

1876—1878.

THE APPARATUS, AND HOW USED.

BY

C. WILLE,
CAPTAIN OF THE ROYAL NAVY.

WITH A FRONTISPIECE AND 21 ILLUSTRATIONS.

CHRISTIANIA.
PRINTED BY GRØNDAHL & SØN.
1882.

Apparaterne og deres Brug.

Indhold.

Som nævnt i min Afhandling om Nordhavs-Expeditionens Oprindelse og Rejser blev det, da Expeditionens Iværksættelse var besluttet, overdraget mig at anskaffe de til Udførelse af de forskjellige Slags Iagttagelser og andre Arbejder nødvendige Apparater. Under min Rejse til England i 1875 anskaffedes saaledes flere Apparater og Instrumenter efter de fra tidligere Expeditioner anerkjendte Modeller. I Løbet af Vinteren 1875—76 udførtes de øvrige Apparater og andre Sager ved norske Verksteder efter de af mig opgivne Tegninger og Betingelser, ligesom jeg organiserede og jevnlig udførte Apparaternes Anvendelse ombord.

Til Grund for den følgende Afhandling, hvis Indhold er angivet ovenfor, er lagt de udførlige Rapporter om Ap-

The Apparatus, and How Used.

Contents.

The Government having resolved to despatch a Scientific Expedition to the Northern Seas, I undertook, as already stated in my account of the origin and cruises of the Norwegian North-Atlantic Expedition, at the instance of the Directors of the Geographical Survey, to procure the various instruments and appliances wherewith it would have to be furnished. Several of these, tested and approved by the experience of former Expeditions, I had constructed in England, from models, when visiting that country in 1875. The remaining apparatus, together with all minor implements requisite for the equipment of the vessel, were made at Norwegian workshops, in the winter of 1875, myself furnishing the designs, and stipulating the conditions on which the work was supplied. Moreover, on the captain devolved the duty of placing and arranging the apparatus, and, as a general rule, of superintending their use on board.

This descriptive exposition, the contents of which have been given above, is in the main an abstract of the special

paraterne og deres Brug, som jeg navnlig i 1876 men ogsaa de følgende Aar indsendte til Direktionen for den geografiske Opmaaling. Fremstillingen er imidlertid bleven for en Del omarbejdet og udvidet, hvad der navnlig gjælder Kapitlet om Navigationen. Efter Professor Mohns Ønske er ogsaa medtaget de af ham, tildels til andre Øjemed, gjorte Studier over Loddernes Udløbshastigheder, over Varigheden af Lodninger og Skrabninger, over Vandloggens Theori og over Kronometrenes Gang, hvis Resultater finde sin naturlige Plads i denne Afhandling. Professor Mohn har ligeledes ydet værdifulde Bidrag til Udarbejdelsen af de denne Afhandling ledsagende Tegninger.

Reports on the Apparatus and how to work them, drawn up by the author for the Directors of the Geographical Survey, chiefly in 1876, but also in the two following years. Meanwhile, the subject-matter has been carefully revised, and in part expanded, more particularly as regards the section that treats of navigating the ship. At the suggestion of Professor Mohn, Director of the Meteorological Institute, I have incorporated divers investigations, instituted by him partly for other purposes, on the velocity of the sounding-lead, the duration of soundings and dredgings, the theory of the water-log, and the rates of the chronometers, the results of which may be given an appropriate place in this division of the General Report. Furthermore, for not a few of the illustrations I am wholly, or in part, indebted to the pencil of Professor Mohn.

Skibet.

Det til Expeditionen lejede Dampskib, "Vøringen,"[1] var bygget af Træ, og var 35^m (140 n. F.) mellem Perpendiculærerne, 7^m ($22^1/_2$ n. F.) bredt, stak 4^m (13 n. F.) agter og maalte Brutto 344 Tons. Maskinen var paa 55 nominelle Hestekræfter og gav, med et Kulforbrug af 2 Tønder i Timen, Skibet en Fart af $7^1/_2$ til 8 Knob i roligt Vejr. Besætningen bestod af Chef, 2 Officierer, 2 à 3 Styrmænd, 1 Baadsmand, 1 Tømmermand, 8 helbefarne og 8 halvbefarne Matroser, 2 Maskinister, 6 Fyrbødere, 1 Messekok, 1 Skibskok og 1 Tjener.

"Vøringen" viste sig at være et usædvanlig godt Søskib, og afgav i alle Dele tilstrækkelig Plads, uden at der dog kunde siges at være Rum tilovers. Under Expeditionerne var det, som Fig. 1 viser, foruden med de almindelige Stag- og Gaffelsejl, tillige rigget med Topsejl paa begge Master. Stængerne, der det første Aar (1876) vare ganske korte, forlængedes, saavelsom Topsejlene, $0.^m5$ ($1^1/_2$ Fod) i 1877 for at skaffe større Sejlareal, men dette var alligevel for lidet til under almindelige Omstændigheder at bruges alene. Heldigvis indtraf der intet saadant Uheld ved Maskinen, at Expeditionen var henvist udelukkende til Sejlenes Brug. De gjorde imidlertid ofte god Nytte saavel ved Manøvrer som til at hjelpe paa Farten. Ved Skibets Udrustning var forøvrigt ikke gjort Regning paa dets Egenskaber under Sejl. Kulboxerne (Fig. 4 *k*) vare udvidede med en Del af Lasterummet under Mellemdækket, saa at de rummede indtil 1400 Tønder, en Forsyning, der var fuldt tilstrækkelig for den længste Tid, som Expeditionen holdt Søen.

Fig. 2 i Forbindelse med Fig. 1 viser de forskjellige Apparaters Plads paa det øverste Dæk. Midten af dette indtages af en Overbygning eller Hytte, hvis Dæk er frem-

[1] Opkaldt efter Vøringfossen i Hardanger.

The Ship.

The S. S. "Vøringen,"[1] the vessel selected for the Expedition, was built of wood, had a length of 144 feet between the perpendiculars, $23^1/_2$ feet beam, and measured 344 tons gross weight. Her engines were of 55 horse power, nominal, and propelled her in calm weather at the rate of from $7^1/_2$ to 8 knots an hour, with a consumption of 430 pounds of coal. The ship's complement consisted of the captain, 2 chief officers, 2 mates (on the last cruise there was a third mate), the boatswain, the carpenter, 8 able and 8 ordinary seamen, 2 engineers, 6 firemen, a steward, the ship's cook, and one servant.

The "Vøringen" proved an excellent sea-boat, and afforded sufficient accomodation, though it cannot be said there was room to spare. She carried on the three cruises of the Expedition (see Frontispiece), exclusive of the usual fore-and-aft sails, a top-sail on either mast. The top-masts, which were rather short, I had lengthened a foot and a half for the second cruise, in 1877, as also the top-sails, to give greater spread of canvas; but this was still insufficient for working the ship under all plain sail. Fortunately, no such accident occurred to the engine or the screw as would have left the sails our only resource. Yet they often stood us in good stead, no less in handling the ship than to increase her speed. For the rest, the qualities of the "Vøringen" as a sailing-vessel had not been taken into account when equipping her for the Expedition. The dimensions of the coal-bunkers (Fig. 4 *k*) were increased, by encroaching on the hold below the orlop-deck, to admit, if necessary, of stowing about 150 tons, a supply amply sufficient for the longest cruise the Expedition would undertake.

Figs. 1 and 2 show together the general arrangement of the apparatus on the upper deck. The middle portion of the latter was occupied by a roundhouse, of which

[1] Named after the "Vøringfos," a celebrated waterfall in Hardanger.

Fig. 1.

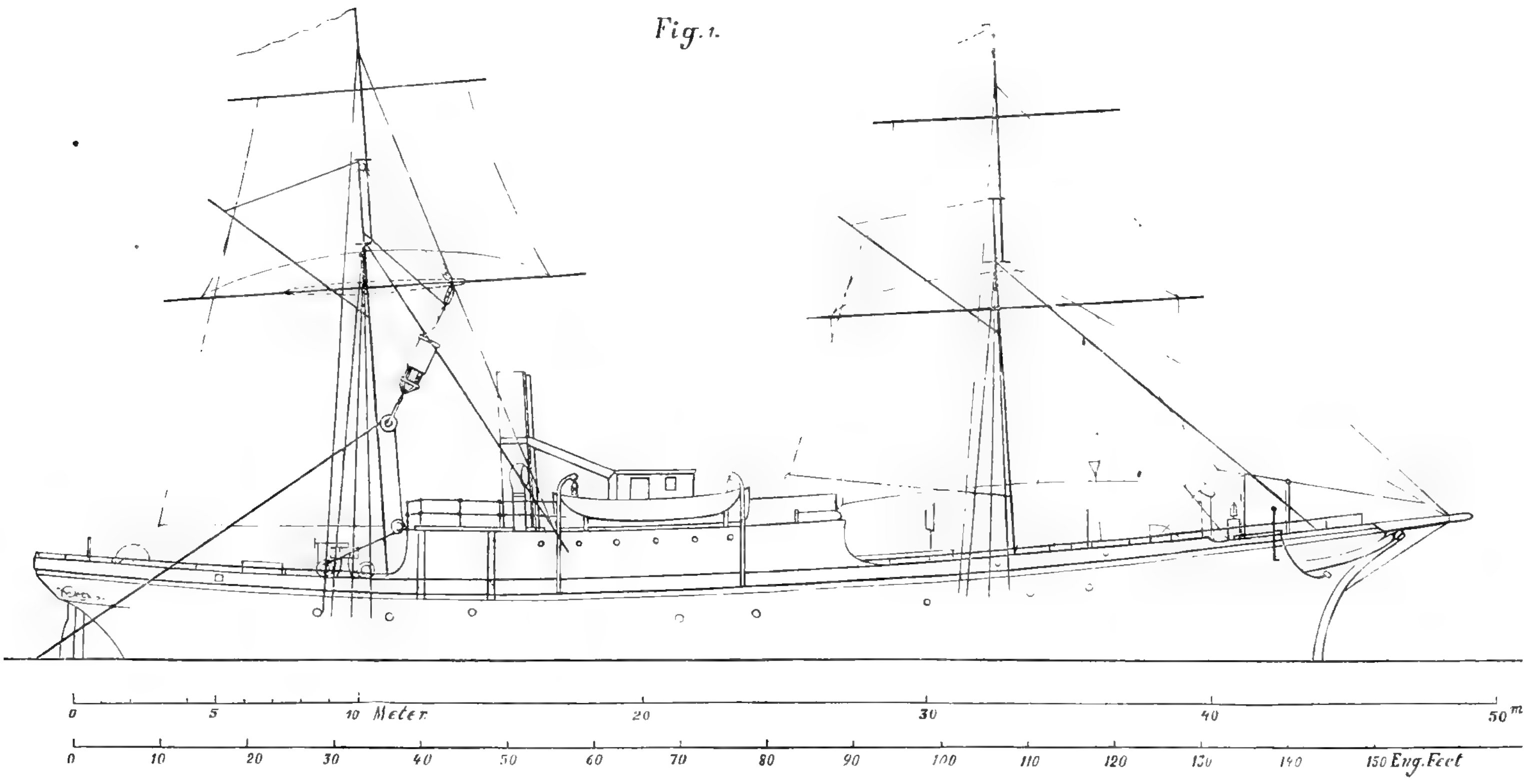


Fig. 2.

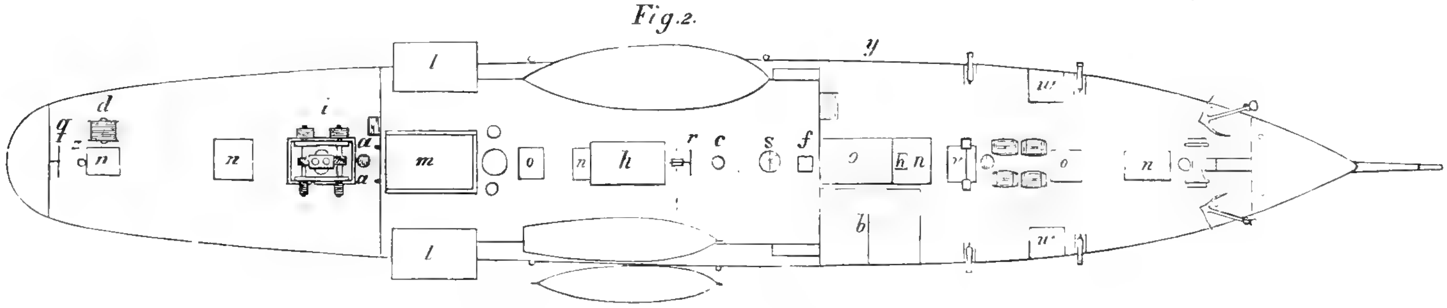


Fig. 3.

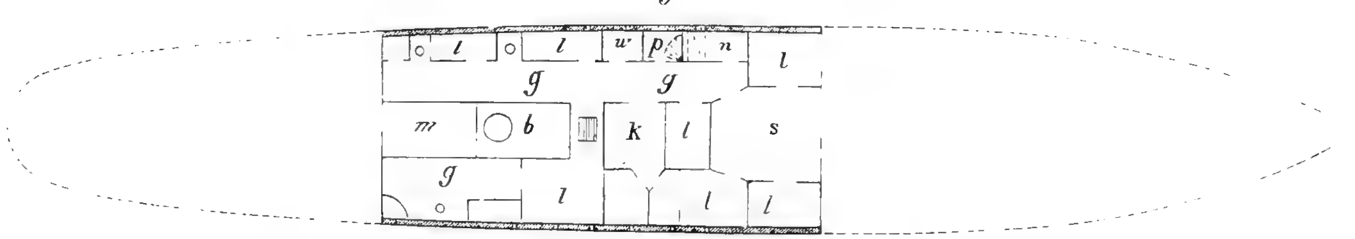
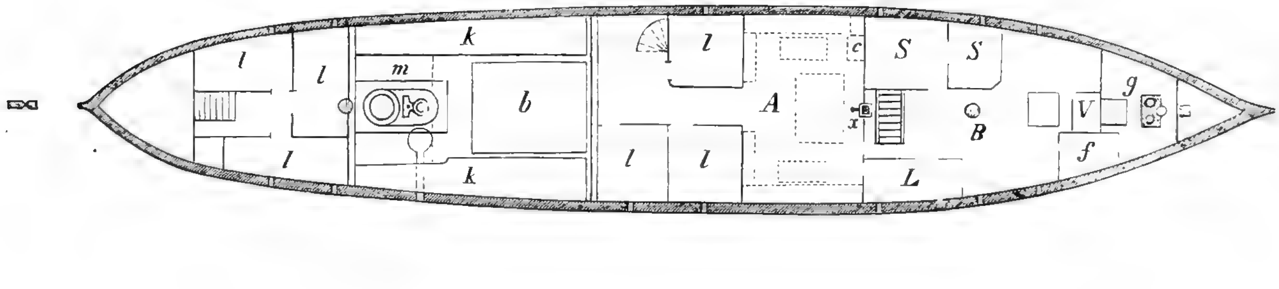


Fig. 4



stillet i Fig. 2 og Indredning under Læ i Fig. 3. Agtenfor Fokkemasten stod en almindelig *Dampwinch* (Fig. 2 *v*), der ved Hjælp af en Kjettingkabellaring kunde benyttes til Ankerhivning. Forrenfor Hytten om Styrbord var opslaaet af Planker en *Binge* (*b*) med 2 Afdelinger, der tilsammen rummede indtil 6000 Favne *Skrabetoug*, og i denne laa Touget klart og luftigt. Paa Fordækket var ligeledes i 1877 og 1878 anbragt 4 *Falconetter*, der med Rapperter og andet Tilbehør velvillig blev udlaant til Expeditionen fra Bergens Værft.

Paa *Hytten* var anbragt en af Skibets *Baade* om Styrbord og udenfor denne hang i Daviderne en Skjække. Om Bagbord stod Expeditionens store Livbaad, 8.^{m}5 (27 Fod) lang, 2.^{m}3 (7. Fod) bred og 1.^{m}3 (4 Fod) høj i Stevnene. Midskibs i Forkant stod Stativet med Balancebordet til *Fox-Cirkelen* (*f*) og agtenfor Skylightet til Spisesalonen (*s*) stod *Standardkompasset* (*c*) og *Styreapparatet* (*r*). Rathjulet bevægede med Drev den lavere liggende Ratstamme, og i Tandkronen om denne laa Bugten af Kjettingen, der gik gjennem almindelige Skildpadder først ud i Borde, derefter langs Hyttetaget, saa ned paa Agterdækket og agterover langs dette, og endelig gjennem Skildpadder i Borde agterud og paa Rorpinden, der viste agterover. Paa Grund af denne lange Ledning virkede Apparatet langsomt. I 1876 var Kjettingen smekrere og virkede agterud med dobbelt Part paa Rorpinden, i hvis Ende der var tilsvarende Blokke. Den blev let slak og var tilbøjelig til at komme i Uorden. I 1877 anbragtes en sværere Kjetting, der virkede direkte paa Rorpinden, hvorved de nævnte Ulemper hævedes. Det blev aldrig nødvendigt at ty til Vareratttet agter (*q*). Lige agtenfor Styreapparatet blev i 1877 opsat et *Bestikhus* (*h*). Paa begge Sider af Hyttedækket og i Agterkant af samme var udbygget *Loddebroer* 3.^{m}1 (10 Fod) lange og 1.^{m}9 (6 Fod) brede (Fig. 2, *l*, Fig. 14 og 21), forsynede med Jernrækverk og støttede med Stræbere mod Skibssiden. I Agterkant af Hytten og paa begge Sider af midtskibs var anbragt "antifriction" *Fodblokke* (Fig. 2 *a*, Fig. 14 og 21), der vare hukede i lange Øjebolte, som løb ned langs Agterkanten af Hytten og gjennem Dæksbjelken.

Paa *Agterdækket* strax agtenfor Stormasten stod *Indhivningsmaskinen* (Fig. 2 *i* og Fig. 5). Den var leveret fra Nylands mekaniske Verksted i Christiania. Den dobbelte vertikalt staaende Højtryksmaskine paa 8 Hestes Kraft drev rundt en under samme langskibs liggende Axel, der forrenfor og agtenfor Krumtapperne var forsynet med to Skruer uden Ende. Disse greb i Tandhjul (Diameter 0.^{m}47 = 1 Fod 6 Tom), der havde svære horizontalt og tverskibs liggende Axler, 2.^{m}37 (7 Fod 6$^1/_2$ Tom.) lange, og paa Nokkerne af disse udenfor Lagerne i Ramverket var Tapperne indsmøgede og fæstede med Kiler. Tapperne om Styrbord, der brugtes til Indhivningen af Skrabetouget,

Fig. 2 represents the roof and Fig. 3 the interior fittings. Abaft the foremast was a *Steam-winch* (Fig. 2 *v*), which, when connected with a chain-messenger, would serve for heaving the anchor. In front of the roundhouse, on the starboard side, had been fitted up a spacious and well-ventilated *Locker* (*b*), with two compartments, affording room for stowing away 6000 fathoms of *Dredge-rope*, ready for immediate use. On the forecastle had been mounted, for the cruises in 1877 and 1878, 4 howitzers, kindly lent to the Expedition, along with the carriages &c., from the Royal Dockyard at Bergen.

The roof of the roundhouse, on the starboard side, supported one of the ship's *Boats*, alongside of which, suspended on davits, hung a small skiff. On the port side was placed the lifeboat of the Expedition, 28 feet long, 7 feet beam, and 4 feet deep in the stems. In the forepart, amidships, stood the foot of the balance-board for the Fox-circle (*f*), and abaft the mess-room skylight (*s*) were the *Standard-compass* (*c*) and the *Steering-apparatus* (*r*). By means of cogwheels, the motion of the steering wheel was transmitted to the barrel; and round the latter, over a toothed wheel, lay the bight of the chain, which, on being rove through cheek-blocks in the ship's side, was carried along the roof of the roundhouse down along the after-deck, and then, through cheek-blocks in the ship's side, right aft on to the tiller. With so long a lead, the working of the apparatus proved somewhat slow. On the first cruise, in 1876, the chain had been of smaller size, and rove double on the tiller, through corresponding blocks at the end; hence it easily got slack, and was apt to kink. In 1877, therefore, we substituted a stouter chain, which led singly to the tiller, and were thus able to remedy the defect. On no occasion had we, however, been compelled to have recourse to the spare wheel aft (*q*). Immediately abaft the steering-apparatus, was a small deck-house (*h*), put up in 1877, containing the log-slate, charts, &c. From both sides of the roof of the roundhouse, and from its after extremity, projected *Sounding-bridges*, 10 feet long by 6 feet wide (Fig. 2 *l* and Figs. 14, 21), with an iron railing, and supported by stays against the ship's side. At the after end, and on both sides, of the roundhouse, there were antifriction *Blocks* (Fig. 2 *a*, and Figs. 14 and 21), hooked to long eye-bolts extending down along the after-bulkhead of the roundhouse and thence through the nearest deck-beam.

On the *After-deck*, immediately abaft the mainmast, was placed the the *Donkey-engine* for hoisting the dredging and sounding gear (Figs. 2 *i* and 5), made at the Nyland Works, Christiania. This double-cylinder, high-pressure, vertical engine, of eight horse-power nominal, imparted a rotary motion to a shaft extending fore and aft beneath it, and provided with a pair of endless screws, one before and one behind the cranks. These screws bit into cog-wheels (diameter 1 foot 6$^1/_2$ inches), fixed on stout horizontal shafts, 7 feet 9$^1/_2$ inches long, lying athwartships; and to the ends of these shafts, which projected beyond the bearings on the frame, were fixed the drums, firmly secured

var 0.m41 (1 Fod 4 Tom.) lange og 0.m42 (1 Fod 4 Tom.) i Diameter. Tapperne om Bagbord, der brugtes til Indhivning af Lodlinen, vare 0.m41 lange og 0.m73 (2 Fod 4 Tom.) i Diameter. Alle 4 Tapper havde 5 Furer eller Rifler. Afstanden mellem forreste og agterste Tappecentrer var 1.m14 (3 Fod 7.6 Tom.). Tapperne blev saaledes drevne samtidig rundt med lige Hastighed og samme Vej. Maskinen viste sig særdeles hensigtsmæssig, idet den arbejdede sikkert og kraftigt, kunde baade hale og fire, uden at man behøvede at skifte Linen paa Tapperne, og man undgik

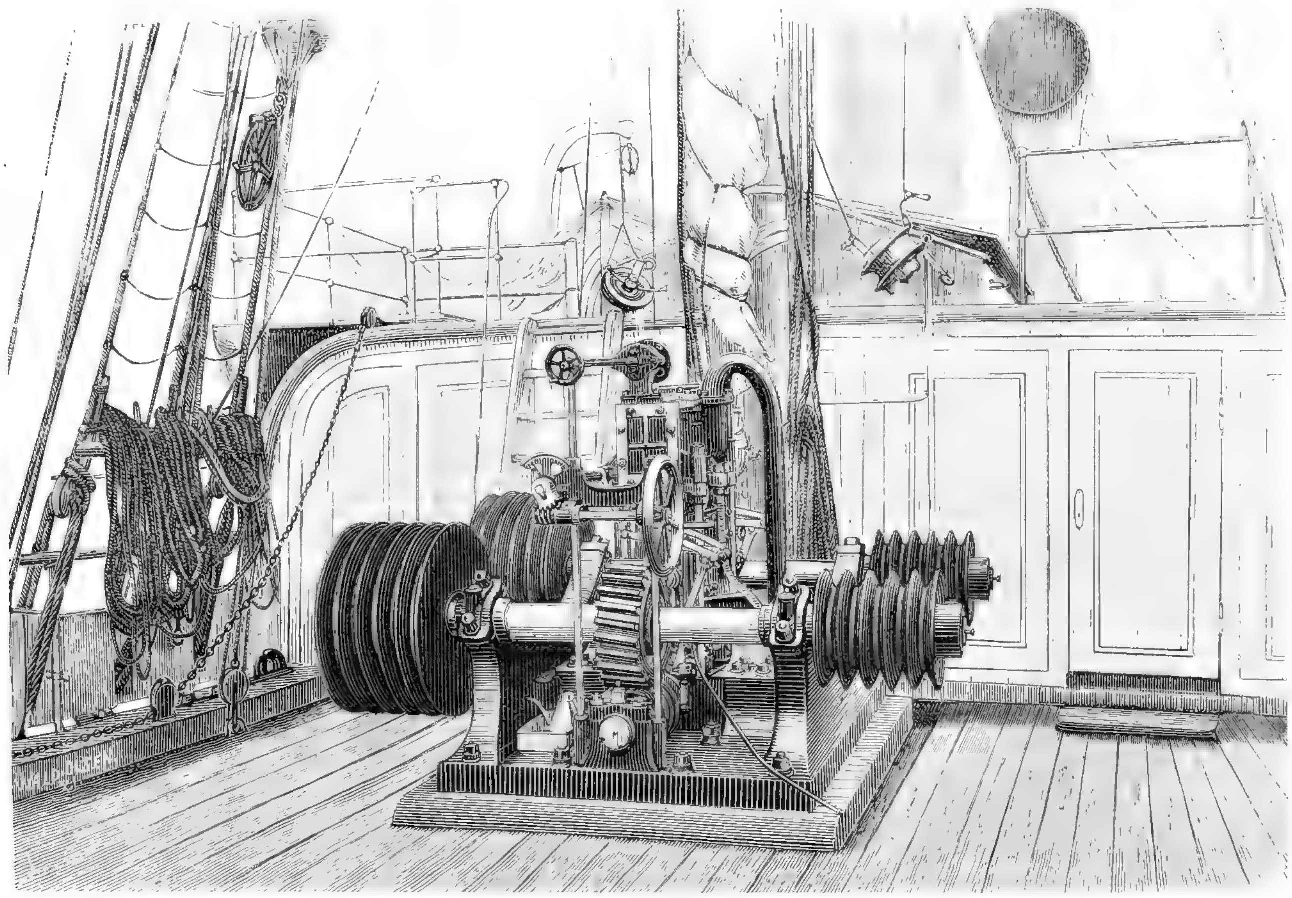


Fig. 5.

Skrændsningen, der følger med Indhivning paa én konkav Tap. De store Tapper om Bagbord tog ind 100 Favne (183 Meter) af Lodlinen i 3 Minuter, og de smaa om Styrbord 100 Favne af Skrabetouget i 6 à 7 Minuter.

I Begyndelsen blev den brugte Damp fra Højtrykscylinderne ledet i en Slange over Dækket og ud over Skibssiden om Styrbord. Da Dampen ved dette Arrangement jevnlig blæstes ind over Dækket og generede, sattes et Kobberrør som Dampskorsten ret op bag Stormasten, hvorved den nævnte Ulempe hævedes.

by keys. The drums on the starboard side, for hauling in the dredge-rope, had a length of 1 foot $4^1/_4$ inches, and were 1 foot $4^1/_2$ inches in diameter; those on the port side, for bringing in the sounding-line, had a length of 1 foot $4^1/_4$ inches, with a diameter of 2 feet $4^7/_8$ inches. The 4 drums had each of them 5 flutes, or grooves. Between the foremost and hindmost pair of drums, measured from centre to centre, the distance was 3 feet $9^5/_{16}$ inches. Hence it is obvious, that the drums would revolve simultaneously, with equal velocity and in the same direction. The donkey-engine proved a most efficient little machine, working with surprising steadiness and ease; we could haul in or pay out the line without having to shift it on the drums, and there was no surging, which cannot be avoided when the drum is concave. The large drums on the port side delivered 100 fathoms of sounding-line in 3 minutes, and the small ones on the starboard side, 100 fathoms of dredge-rope in 6 or 7 minutes.

On the first cruise, the waste steam escaped through a hose on deck over the starboard side of the vessel; but being with this arrangement, frequently blown back, to the inconvenience of those on deck, the following year a copper steam-pipe was put up abaft the mainmast to get rid of the nuisance.

Ved Siden af agterste Luge var anbragt om Bagbord en Rulle (Fig 2 *d*, Fig. 13 og 14), paa hvilken der kunde oprulles indtil 3000 Favne (5500^m) Lodline. I 1876 havde vi en Reserve-Rulle om Styrbord, men denne blev aldrig benyttet.

I Fig. 2 er forresten *n* Nedgangskapper, *o* Skylighter, *m* Maskin-Skylightet, *h* Lufthat, *w* Waterclosets.

Fig. 3 viser Apteringen af *Rummet i Hytten*. *gg* ere Gange paa begge Sider, *s* Spisesalong, *k* Kabys, *l, l, l* ... Sovelugarer, *n* Nedgang til Mellemdækket, *p* Sterrids, *m* Maskin-Skylightet, *b* Kjedlen.

Baade forrenfor og agtenfor Maskinen blev lagt *Mellemdæk*. Apteringen af dette er vist i Fig. 4. *A* er Arbejdssalonen, der indtager Skibets hele Bredde. Den var i 1876 noget mindre, idet Forskuddet stod 0.^{m}6 (2 Fod) længere agter og der var her saavelsom i Lugarerne med Hensyn til Maling og Udstyr anvendt den største Sparsommelighed. Midt under Skylightet, der var anbragt i Skibets Storluge, stod Zoologernes Bord. Meteorologen havde sit Bord om Bagbord og Kemikeren sit om Styrbord. I Figuren betegner *c* om Bagbord Kronometerskabets Plads. Midskibs paa Forskuddet hang Sobarometret. *l, l, l* ... ere Sovelugarer, 3 foran og 3 agtenfor Maskinen. Fra Carljohansværns Verft erholdtes udlaant Chiffonierer, Vaskevandstole, Feltstole samt fornødent Kojetøj til Lugarer og Mandskab, men Rammekojerne i Lugarerne blev senere paa Turen ombyttede med Slingrekojer af Træ, som Tømmermanden forarbejdede. Erfaringen fra det første Aar viste, at det var nødvendigt at anvende noget mere Bekostning paa Indredningen, navnlig med Hensyn til Lys og Luft. Kemikerens Arbejde generede ofte de øvrige Herrer, ligesom Skibslugten var en stor Plage, naar Vejret ikke tillod Luftning gjennem Skylightet. Til 1877 Aars Togt blev der derfor gjort flere Forbedringer. Forskuddet i Arbejdssalonen flyttedes 0.^{m}6 (2 Fod) længere forefter. Om Styrbord indrettedes paa Banjerne (*B*) særskilt Laboratorium (*L*) for Kemikerne, med Indgangsdør fra Salonen. Denne blev ordentlig malet med lysgrøn Farve og Gulvet blev tættet og trukket med Voxdug. Langs Forskuddet opsattes en Luftrende (*h*) af 0.1^{qm} (1 Kvadratfods) Tversnit, der ledede frisk Luft ned i Salonen (Fig. 2 *h* og Lufthatten, Fig. 1, der kunde vendes mod Vinden). Den slette Luft førtes ud gjennem et Blikrør, der fra Gangen udenfor Lugarerne gik over Kjedlen (*b*) og op forrenfor Skorstenen. Skuddet paa Forkant af Dampkjedlen (*b*) blev gjort dobbelt og den i Mellemrummet staaende varme Luft givet Afløb paa lignende Maade. Lugarerne agterud havde ogsaa en lignende Ventilationsindretning. Samtlige Lugarer og Banjerne, hvor Folkene laa i Hængekojer, havde Ventiler i Skibssiden, saaledes som man ser af Fig. 4 og Fig. 1. Lugarerne bleve trukne med hvidt Tapetpapir og Gulvet klædt med Voxdug. De vare meget rummelige og tørre, men varme, naar der var Fyr paa Kjedlen og noget mørke. Varmeledningen, som det første Aar kun bestod af et Jernrør, der var ledet gjennem de forskjellige Rum, blev forsynet med Aftapningskraner og særskilte Dampovne af Kob-

Alongside the aftermost hatchway, on the port side, was placed a large, strong reel (Fig. 2 *d*, and Figs. 13, 14), which held 3000 fathoms of sounding-line. In 1876, we had a spare reel on the starboard side; but it was never used.

Explanation of Fig. 2: — *n* companion hatchways; *o* skylights; *m* skylight over engine-room; *h* ventilator; *w* waterclosets.

Fig. 3 shows the arrangement of the *Deck below the Roundhouse*: — *gg* passages on both sides of the ship; *s* messroom; *k* cooking-range; *l, l, l* ... cabins; *n* companion-ladder to orlop-deck; *p* pantry; *m* skylight over engine-room; *b* boiler.

An *Orlop-deck*, fitted up as shown in Fig. 4, had been laid fore and aft from the engine. The common work-room, *A*, occupies the whole breadth of the ship. The first year of the Expedition it was a trifle smaller, the foremost bulkhead being 2 feet farther aft. Amidships, under the large skylight, for which an opening had been cut in the main-hatch, was placed the zoologists' table; another, that of our meteorologist, stood on the port side; and on the starboard side a third, for the chemical work done on board. In Fig. 4 *c*, on the port side, is shown the case for the chronometers. Amidships, from the foremost bulkhead, was suspended the marine barometer. In the same figure *l, l, l* ... are a row of cabins, 3 on either side of the engine, fore and aft. From the Royal Dockyard of Carljohansværn the Expedition procured cabin furniture, such as chests of drawers, washing-stands, camp-stools, &c., and the necessary bedding both for the cabins and the sailors' hammocks; but in place of the canvas berths we afterwards substituted wooden swinging-berths, made on board by the carpenter. The experience of the first year's cruise, showed some additional outlay for remedying defects in the general arrangements below deck, in particular those connected with light and ventilation, to be highly desirable. Unsavoury smells emitted during the chemical work, would hang about the room, and the foul air from the bilge proved a great nuisance in weather that did not admit of ventilating through the skylight. Divers improvements were accordingly effected before commencing the cruise in 1877. We had the dimensions of the work-room increased, by moving the foremost bulkhead 2 feet farther forward. On the starboard side of the orlop-deck (*B*), a separate laboratory (*L*), opening into the work-room, was fitted up for the chemical work to be done on board. The work-room got a good coating of light-green paint; and after filling up the chinks, the floor was covered with oil-cloth. Along the foremost bulkhead we put up a ventiduct (*h*), 1 foot square, down which an uninterrupted current of fresh air found its way into the work-room (Fig. 2 *h*; Fig. 1 represents the moveable top of the ventilator, which could be turned in any direction to catch the wind). To get rid of the vitiated air, a tin pipe was laid along the roof of the passage extending past the cabins, being carried thence over the boiler (*b*), and up the front of the funnel. Moreover, there being now a double bulkhead afore the boiler (*b*), like provision was made for the escape of

ber i hvert Rum. I Fig. 4 er endvidere *S, S* Styrmændenes Rum, *f* Fyrbødernes, *g* Kabysen for Mandskabet, *r* Vandtank, *b* Kjedlen, *m* Maskinen, *k* Kulboxerne.

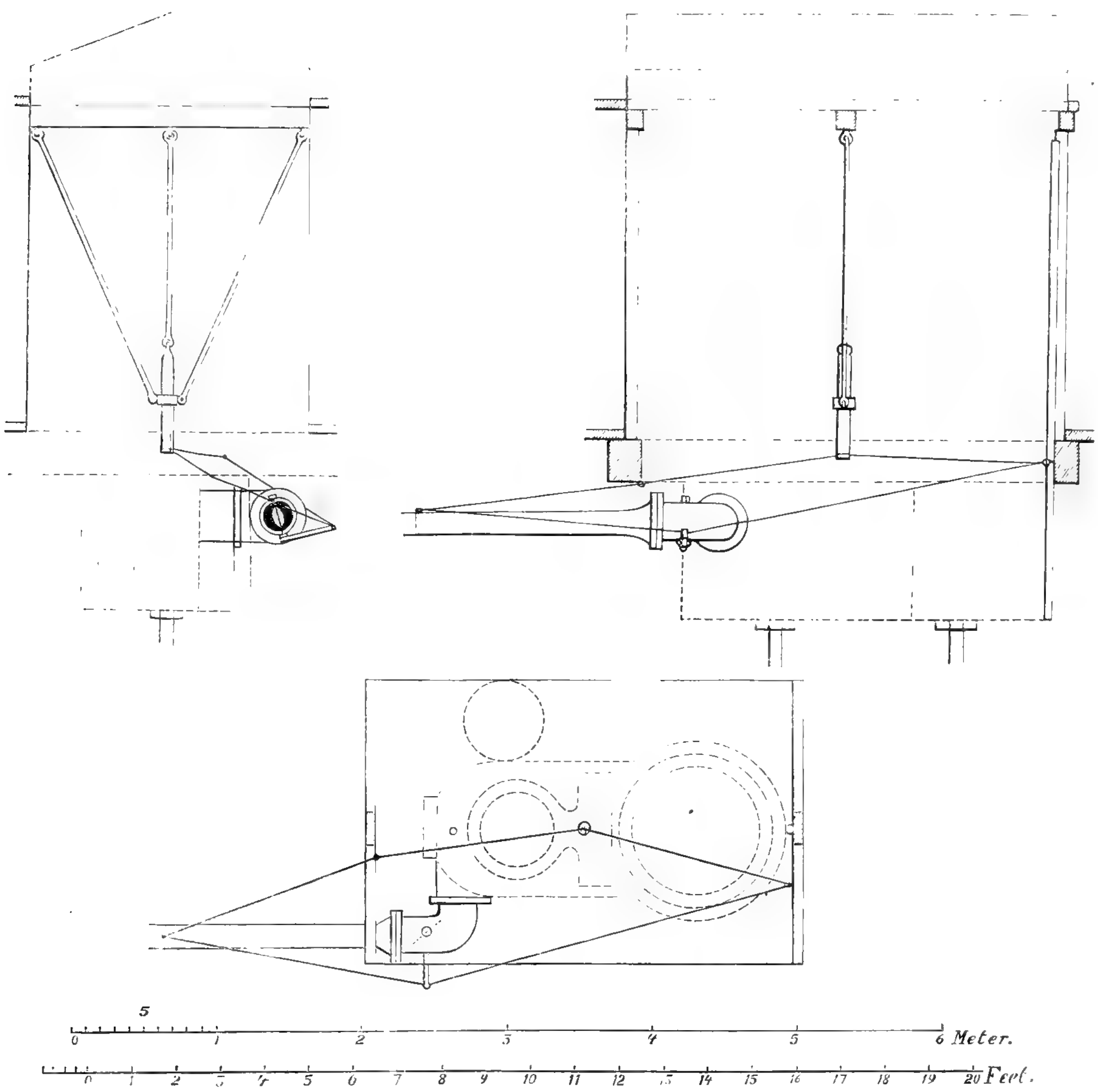


Fig. 6.

Samtidig med Skibet skal jeg omtale *Petersens Pendel-Regulator*, Fig. 6. Som bekjendt er det er stor Ulempe,

the heated air between the two partitions. For the cabins aft, too, we adopted this mode of ventilation. Each compartment, as also the orlop-deck, where the crew slung their hammocks, had bull's eye windows (Figs. 4 and 1). The cabins were all of them papered white, and had their floors covered with oil-cloth. They were very commodious, and dry withal, but somewhat dark, and with the steam up, rather close, from their proximity to the boiler. The warming-apparatus, which on the first year's cruise had consisted merely af an iron pipe extending from compartment to compartment throughout the vessel, was now provided with stopcocks for turning on the steam into copper receptacles, or stoves, as they are called, of which each room and compartment had one. Fig. 4 also represents the mates' cabin (*S, S*), the firemen's compartment (*f*), the ship's galley (*g*), the water-tank (*r*), the boiler (*b*), the engine (*m*), and the coal-bunkers (*k*).

In my description of the ship and her equipment I must not omit to mention *Petersen's Pendulum-governor* (Fig. 6).

naar Skruefartøjer skal gaa ret mod eller ret undaf Vinden i høj Sø, at Skruen til enkelte Tider kommer ud af Søen, eller i alle Fald saa høit op i Vandet, at den tager en saadan Fart, at der let kan opstaa Havari i Maskinen. Erfaring lærte, at "Vøringen" klarede sig bedst i høi Søgang, naar den blev lagt med Stevnen ret mod Søerne, men naar Bølgetoppen havde passeret Skibets Midte, faldt Bougen ned i Bølgedalen og Skruen, som derved løftedes op i Vandets Overflade, slog da saa haardt, at Maskinisten stadig maatte staa med Throttlevalven i Haanden og bremse. Næstcommanderende, Premierlieutenant Petersen, fandt da paa at hænge op et af de store Lodder, der brugtes til Lodningerne, af 112 Pd.s Vægt, under Maskinskylightet, med Forstøtning til Siderne, saaat det blot kunde svinge frem og tilbage i Skibets Diametralplan. I den nedre Ende var fastgjort 2 Snore, der løb gjennem Kouse, en forrenfor Maskinen (over Kjedlen) og en agtenfor samme (i Maskinskylightet) noget ud i Borde, og begge Snore var med de nedre Ender fastgjorte i Haandtaget til Throttlevalven.

Idet Skibet nu faldt ned med Bougen, svingede Loddet forefter, trak derved i den agterste Snor og lukkede Throttlevalven. Naar Skibet atter rejste sig, faldt Loddet tilbage og aabnede igjen for Dampen ved Hjelp af den anden Snor. Grændserne for Loddets eller Ventilens Bevægelser i begge Retninger reguleredes ved et Par paa den agterste Snor fæstede Tværstykker af Træ, der stoppede op imod den agterste Kous i Maskinskylightet.

Gjennem dette enkle Arrangement udførte Loddet den for Maskinisten saa besværlige Tjeneste med Bremsningen, og bedre end han kunde, da Loddet følger Skibets Bevægelser sikkrere end Maskinisten kan. Med fuld Fart hjalp ikke Loddet, da Slideskabet og Cylinderen indeholdt for meget Damp selv efter Throttlevalvens Lukning; men da Maskinisten heller ikke kan gjøre mere end at lukke, er man i dette Tilfælde ved Omstændighedernes Medfør nødt til at regulere til mindre Fart.

It is a well-known drawback with screw-vessels steaming head or stern to wind in a heavy sea, that of the screw being at times either wholly lifted out of the water, or at least brought so near the surface as to cause it to revolve with a rapidity that cannot but expose the engine to serious damage. In rough weather, the "Vøringen" was found to behave best with her head to the sea; but when the crest of a wave had passed the middle of the ship, she would plunge her bows into the trough of the sea, and the screw, being then proportionally raised, tore round with such critical violence at the surface of the water that the engineer had to be constantly on the alert, ready at any moment to shut the throttle-valve and cut off the steam. Observing this and the trouble it entailed, Lieutenant Petersen, our second in command, hit upon the ingenious device of suspending as a governor under the engine-room skylight one of the heavy leaden sinkers, weight 112 lbs., which he made to swing right fore and aft. At the bottom end of the sinker were fastened two lines, rove through thimbles, one before the engine (over the boiler), and the other abaft it (on the engine-room skylight), a little to the port side, the other two ends being made fast to the hand-lever of the throttle-valve.

Now, when the vessel pitched, the sinker swung forward, and, pulling upon the afterline, closed the throttle-valve; on her again rising, the sinker swung back, opening the steam-passage by its drag on the other line. The motion both of the sinker and of the valve was kept within proper limits by two cross-pieces of wood on the after line, fixed one on each side of the after thimble.

By this simple arrangement, the engineer was relieved from the troublesome duty of throttling, which the sinker performed even more effectually, following the motion of the vessel with far greater nicety than the most watchful eye. At full speed, our pendulum-governor was of no avail, the valve-casing and the cylinder then containing too much steam, even with the throttle-valve closed; however, as the engineer can do no more than cut off the steam, in that case there is nothing for it but to reduce the speed.

Lodning.

Lodderne. Naar Dybden ikke antoges at være over 1000 Favne, anvendtes det saakaldte Rør-Lod. Til Lodning paa større Dyb brugtes Baillie-Maskinen.

Rør-Loddet (Fig. 7) er af Bly 0.m77 (2 Fod 5½ Tom.) langt, 0.m078 (3 Tom.) tykt og vejer 56 Kgr. (112 Pund). Det har i den nedre Ende et i en Messingmuffe indskruet Jernrør 0.m23 (9 Tom.) langt, 0.m052 (2 Tom.) bredt til Optagning af Prøver af Bunden. Dette Rør har i den øvre Ende nogle Huller for at Vandet kan slippe ud, naar Bundprøven trænger ind nedenfra, og i den nedre Ende en Butterfly-Ventil, der aabner sig opad, og som hindrer Bund-

Deep-sea Sounding.

When the depth was supposed not to exceed 1000 fathoms, we used the tube-lead, as it is called. For sounding in greater depths the Baillie machine was employed.

The *Tube-lead* (Fig. 7), 2 feet 6½ inches long by 3 inches thick, is of lead, and weighs 112 lbs. At the lower end it has a brass box, into which is screwed an iron tube, 9 inches long by 2 inches in diameter, for bringing up samples of the bottom. This tube has the upper end perforated with a number of holes, to allow of the water passing out above on the sample of the bottom pressing in from beneath, and is furnished at the lower end with a butterfly valve, open-

prøven fra at skylles ud af Roret under Ophalingen. Naar Røret er afskruet, kan et Sidestykke tages ud, hvorved Bundprøven kommer tilsyne med sine naturlige Lag og kan undersøges foreløbig, førend den bringes paa de dertil bestemte Opbevaringskar.

ing inwards, to prevent the washing out of the sample on its journey to the surface. The tube screwed off, the sample within, as it lies *in situ*, may, by removing a slip from the side, be disclosed for preliminary inspection, before being taken to the receptacles in which it is stored

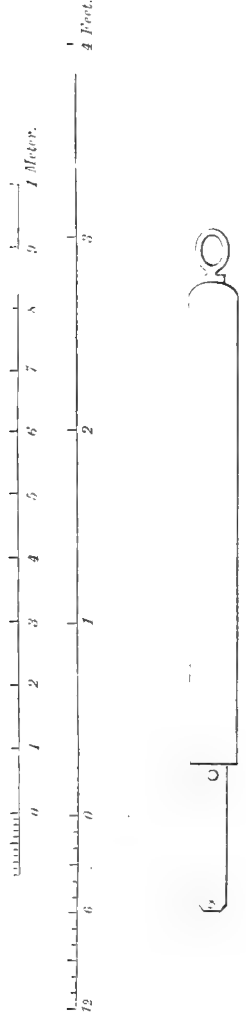


Fig. 7.

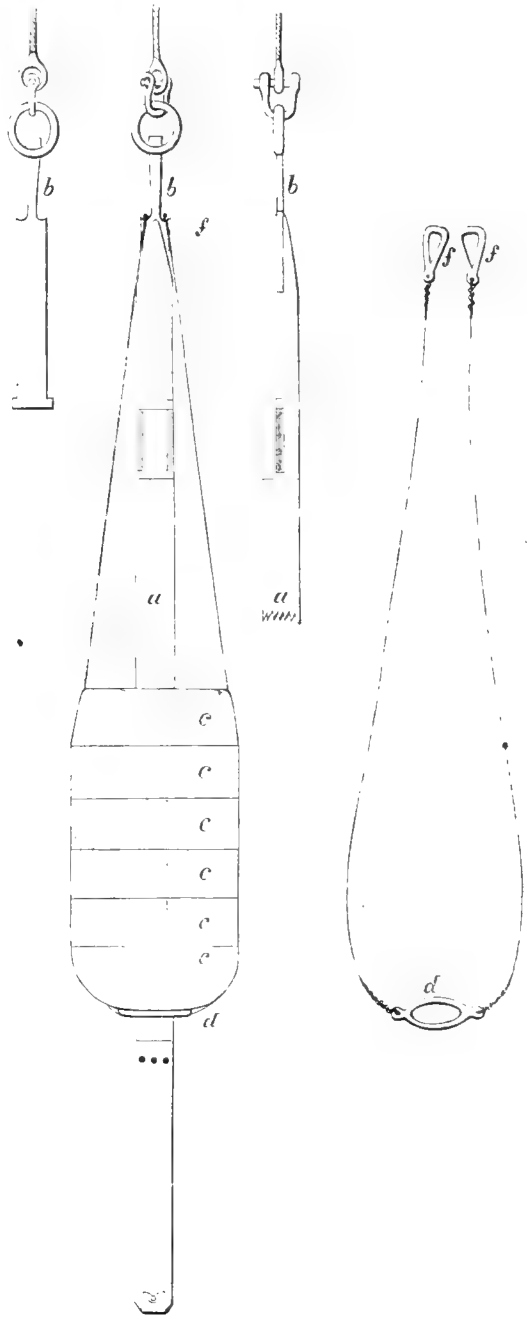


Fig. 8.

Baillie-Maskinen (Fig. 8) bestaar af et 1.^{m}75 (5 Fod 7 Tom.) langt, 0.^{m}061 ($2^1/_3$ Tomme) bredt Ror, *a*, hvis øvre Del er af Messing og tilspidset. I Spidsen er en Gjennemskjæring, og længere nede i Flugt med denne en

The *Baillie Sounding-machine* (Fig. 8) consists of a tube *a*, 5 feet 9 inches long by $2^1/_3$ inches in diameter, the upper portion of which is of brass, bevelled away to a long rounded slope. At this end it has a slot,

Aabning paa hver Side. Stykket *b*, der har en Bredde, som er noget mindre end Røret *a*'s indvendige Diameter, er indsat i dette saaledes, at Knasterne ved *b*'s nedre Ende kommer frem i Sideaabningerne, og Stykket *b* kan saaledes bevæges op og ned, fra at Knasten støder an mod Overkant til den støder an mod Underkant af Aabningen. I sidste Tilfælde er *b* ganske skjult inde i Røret med Undtagelse af Ringen. I den nedre Ende af Røret *a* er anbragt den samme Indretning til Optagning af Bundprøve som paa Rør-Loddet.

Til Maskinen hører Jernlodderne *c*, *c*, *c*, af hvilke hvert har en Vægt af omtrent 27 Kilogram (55 Pd.). De ere korte Cylindre af støbt Jern med et Hul i Midten af noget større Diameter end Røret *a*'s og med Knaster paa Oversiden samt tilsvarende Fordybninger paa Undersiden og desuden en Fure paa begge Sider, der ligger i Knasternes og Fordybningernes Plan. Naar det ene Lod stables ovenpaa det andet, danner deres Furer en fortløbende Rende. Underlod og Overlod har særskilt Form, som Figuren viser, idet det første er kugleformig afrundet paa Undersiden, for at gjøre mindre Modstand mod Vandet, og det sidste er noget konisk.

Naar Baillie-Maskinen skal rigges, bruges en større cylindrisk Træblok med et Hul i Midten. Over dette lægges Ringen *d*, der er af Støbejern, med isatte Jerntraade, og man stabler nu Lodderne ovenpaa, saa mange som man anser fornødent for med Sikkerhed at kunne angive Øieblikket, da Loddet slaar i Bund. Derefter sættes Røret *a* gjennem Hullerne i Lodderne og Træblokken, Stykket *b* løftes op, Jerntraadene lægges i Jernloddernes Sidefurer, og Ringene *f* hukes paa de øvre Afsatser paa *b*. Naar man nu løfter op i Lodlinen, der er hexet fast til Ringen i Stykket *b*, hænge Lodderne paa Afsatserne paa Stykket *b*, og Røret *a* hænger med Overkant af Sideaabningerne paa Knasterne ved den nedre Ende af *b*, som i Figuren. Naar Maskinen støder mod Bunden, bliver det løst hængende Rør *a* drevet op og trykker med sin øvre koniske og afrundede Del Ringene *f* ud af Afsatserne paa *b*. Derved er Forbindelsen mellem Jernlodderne og Lodlinen ophævet, Lodderne med Ringen *d*, Jerntraadene og Ringene *f* falde ned og blive liggende paa Havbunden, medens Røret *a* og Stykket *b* bringes op til Overfladen, naar Lodlinen hives ind.

Der blev anvendt indtil 8 Lodder af samlet Vægt 216 Kilogram (432 Pd.). Røret, der hales op, vejer kun 17.5 Kilogram (35 Pd.).

Baillie-Maskinen viste sig at være et udmærket Apparat, idet Lodderne hver eneste Gang, den brugtes, gik af Røret, om end Bunden var noksaa blød. Den eneste Van-

and farther down, in a line with the latter, two other openings, one on either side. The piston-iron *b*, not quite equal in width to the inner diameter of *a*, being so fitted into the tube that the studs at its lower extremity correspond with the aforesaid slots, or openings, can accordingly work up and down within those limits. When the studs are at the bottom of the slots, the piston-iron *b* is just within the brass or upper end of the tube, the ring only by which the instrument is shackled to the sounding-line being then above it. For bringing up samples of the bottom, the lower end of the tube has an arrangement similar to that at the bottom of the tube-lead.

To the machine belong a number of sinkers *c*, *c*, *c*, weighing each about 55 pounds, — short cast-iron cylinders, with a hole through the middle slightly exceeding in diameter the tube of the instrument, and toothed and notched so as to fit into one another and make one mass, also having a groove on either side in the same plane with the notches. The top and bottom sinkers differ in shape, the former being slightly conical, and the latter having the lower end spherically rounded, to diminish the resistance and thus increase the velocity in descending.

The Baillie machine was placed for adjustment on a cylinder of wood, having a hole through the middle somewhat greater in diameter than that of the tube *a*. Over the bore of the cylinder is placed a cast-iron ring *d*, with iron wires attached; and upon the ring are piled a number of sinkers, sufficient to determine the exact moment at which the instrument reaches the bottom. The lower part of the tube *a* is next passed through the sinkers into the wooden cylinder beneath; and after drawing out the piston-iron *b*, the wires, forming a sling, are laid in the groove along the sides of the sinkers, and the rings *f* hooked upon the shoulders of the piston. Now, on the instrument being hung to the sounding-line by the ring of the piston-iron, the sinkers will depend, on the iron-wire sling, from the shoulders of *b*, and the tube *a* from the lower studs that retain the piston-iron in position, the brass cylinder being pulled down the entire length of the slots, as shown in the figure. When the tube and the weights touch the bottom, the brass cylinder is pushed upward the length of the slots, and its top rim striking against the rings *f*, the sling is slipped off the shoulders of the piston-iron. The sinkers, being thus deprived of their support, drop, carrying with them the ring *d*, the wires of the sling, and the rings *f*, down the tube *a*, which, on hauling in the line, comes up alone, with the piston-rod and a sample of the bottom.

For some soundings we used as many as 8 sinkers, weighing together 432 pounds. The weight of the tube is only 35 pounds.

The Baillie machine proved an excellent apparatus, the weights being without exception detached from the tube, however soft the bottom. The only difficulty

skelighed var Udfiringen over Rækken og ned i Søen, thi ved Slag mod Skibssiden kunde Jerntraadene løsne og Lodderne tabes. Man firede den derfor saa hurtig som muligt ned i Vandet, hvor dens Svingninger under Fartøjets Bevægelser lettere kunde dæmpes og gjøres uskadelige.

Lodlinerne, der var leverede af Rebslager Timm i Christiania, var af fineste Sort italiensk Hamp, 2.cm6 (1 Tomme) i Omkreds, voxede og glatstrøgne. De holdt ved anstillet Prøve en Vægt af 750 Kilogram (1500 Pd.). De viste sig særdeles gode, og der blev brugt kun en Line hver Sommer. Linen blev mærket for hvert hundrede Favne med omviklede og paamerlede Stykker Flagdug af forskjellig Farve. De første 20 Favne var dobbelt Part med Kous og Hex til Loddet. I 1876 var Lodlinen inddelt i *norske* Favne, og de første 100 Favne havde Lædermærker for hver 10 Favne. I 1877 og 1878 var Lodlinen inddelt i *engelske* Favne og de første 200 Favne opmærkede for hver 10de Favn. Opmærkningen foretoges ombord, idet der med Tommestok blev sat Mærker i Dækket for en Længde af 5 Favne, hvilke ogsaa senere brugtes, naar Linen blev eftermaalt og rettet.

Som anført, havde vi ingen Sprængning af Lodlinen foraarsaget ved at Baillie-Maskinens Lodder ikke gik af Røret. Som Bevis paa Lodlinens Godhed kan anføres, at den under Lodningen en Gang, medens den altsaa var i fuld Fart, gik i Hus i Loddeblokken, idet denne ikke drejede sig hurtigt nok ind i Planet mellem Linens Parter. Uagtet det voldsomme Ryk og det snevre Rum, hvori Linen blev kneben ind i Blokken, over tildels skarpe Kanter, holdt den uden at lide Skade. Den eneste Sprængning af Lodline fandt Sted i 1877 paa Turen nordenfor Tromsø, idet Lodlinen, som under Indhivningen var kommen under Fartøjets Bund, blev grebet af Skruen og sprængt. Ved at fire et Lod i slak Bugt ud fra Stevnen og med Enderne af Linen langs hver af Fartøjets Sider hale det agterud, lykkedes det vagthavende Officer, Capt. Grieg, at fiske Lodlinen, der havde kastet sig om Propelleraxen saa vidt, at den ikke sank; derved reddedes flere Thermometre og de af dem registrerede Bund-Temperaturer.

Accumulatoren bestaar af en Samling Kautschuk-Stroppe (Fig. 9), hver bestaaende af 2 sammenføjede Strenge af 2cm (3/4 Toms) Tykkelse. I hver Bugt er en Træ-Kous med Stjert, og Strengene holdes sammen om Trækousene ved tynde Kautschuk-Ringe. Stroppene ere ordnede mellem 2 stærke Træskiver, 0m.442 (1 Fod 5 Tom.) i Diameter og 0m.045 (1.7 Tom.) tykke, med ligesaamange smaa Huller som der er Stroppe. Stjerten tages gjennem Hullerne og samles om en svær Kous, saaledes at Stroppene blive jevnt stive. Fig. 10 viser Lodde-Accumulatoren. Den be-

lay in lowering the instrument; bumping against the ship's side was apt to disengage the sling, and thus occasion the loss of the sinkers. We therefore got the machine as quickly as possible into the water, where the swinging motion given to it by the rolling of the vessel could produce no injurious result.

The *Sounding-lines,* supplied by Mr. Timm, ropemaker of Christiania, were of the best Italian hemp, 1 inch in circumference, with a breaking strain of 1500 pounds, and well waxed and smoothened. They proved of excellent quality, one amply sufficing for a whole cruise. The lines were graduated into hundreds of fathoms by attached slips of different coloured buntine, wrapped round the surface. Each was rove double the first 20 fathoms, and provided with a thimble and a shackle, by which to make fast the sounding-machine. For the first year's cruise, in 1876, the line was graduated into Norwegian fathoms, and had slips of leather at every 10 fathoms of the first hundred; but for the two remaining cruises, in 1877 and 1878, we substituted English measure, graduating the first two hundred fathoms of the line into tens of fathoms. The line was graduated on board, 5 fathoms having been previously measured out along the deck with a foot-rule. These five-fathom intervals served, too, as a reliable standard when re-measuring and adjusting the line.

As stated above, the weights were detached at every sounding with the Baillie machine; and hence we never had the line carry away from their failing to drop off on the instrument striking the bottom. Meanwhile, the excellence of its quality came on one occasion to be severely tested. When running out with full velocity, the line suddenly caught in the sounding-block, which had not readily adjusted itself to the direction taken by the former on its rapid passage out. But, though brought up in this way with a violent jerk, and jammed besides into the block, partly, too, against sharp edges, the line was strong enough to stand the strain uninjured. The only sounding-line that parted was one used in 1877, on our cruise north of Tromsø. We were hauling in the lead, when it got underneath the ship's bottom, fouled the screw, and was broken. By lowering a weight over the bows in a slack bight, and then, with the ends of the rope extending one along either side of the vessel, hauling it aft, the officer of the watch, Captain Grieg, succeeded in fishing the sounding-line, which had twisted round the screw-shaft just sufficient to keep it from sinking, and thus recovered several thermometers, along with the temperatures they had registered at the bottom.

The *Accumulator* is built up of a number of straps (Fig. 9), each composed of 2 vulcanised india-rubber springs, three-quarters of an inch thick, joined lengthwise. In each of the loops is fixed a wooden thimble, with a lanyard, and the springs are kept together by means of thin india-rubber rings. The straps are kept free from one another and equably taut, by stretching them between a couple of strong wooden disks, 1 foot 5½ inches in diameter and 1¾ inch thick, bored with a hole for every strap, the lanyards being rove through the holes and brought

staar af 15 Stroppe. I den nedre Kous hænger Loddeblokken, der er af Jern, forsynet med Hvirvel, Axe, der løber paa Friktionsruller og to Arme med Hængsler til Styring af Lodlinen. Den øverste Kous hukes i et Topreb, der senere skal beskrives, og det hele Apparat hænger,

together round a large thimble. Fig. 10 represents the Sounding-accumulator, composed of 15 straps. To the lower thimble is hung the cast-iron sounding-block, provided with a swivel, an axle revolving on antifriction rollers, and two hinged arms to act as fairleaders for the line. The upper

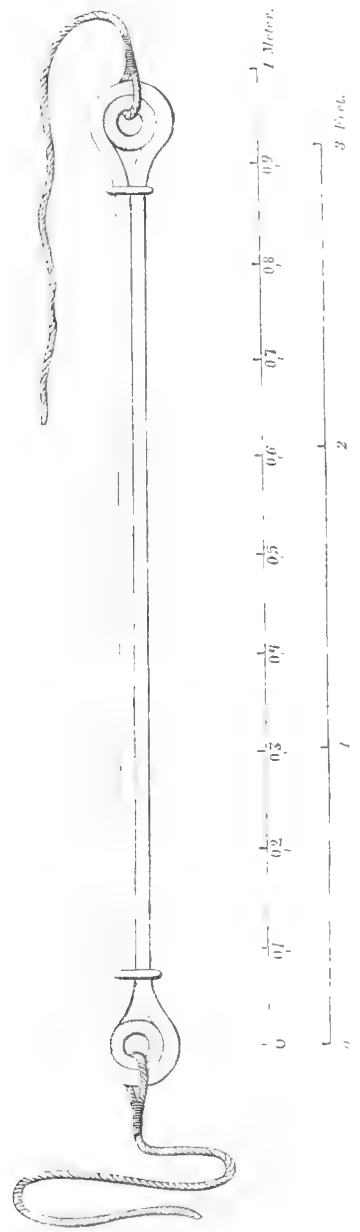


Fig. 9.

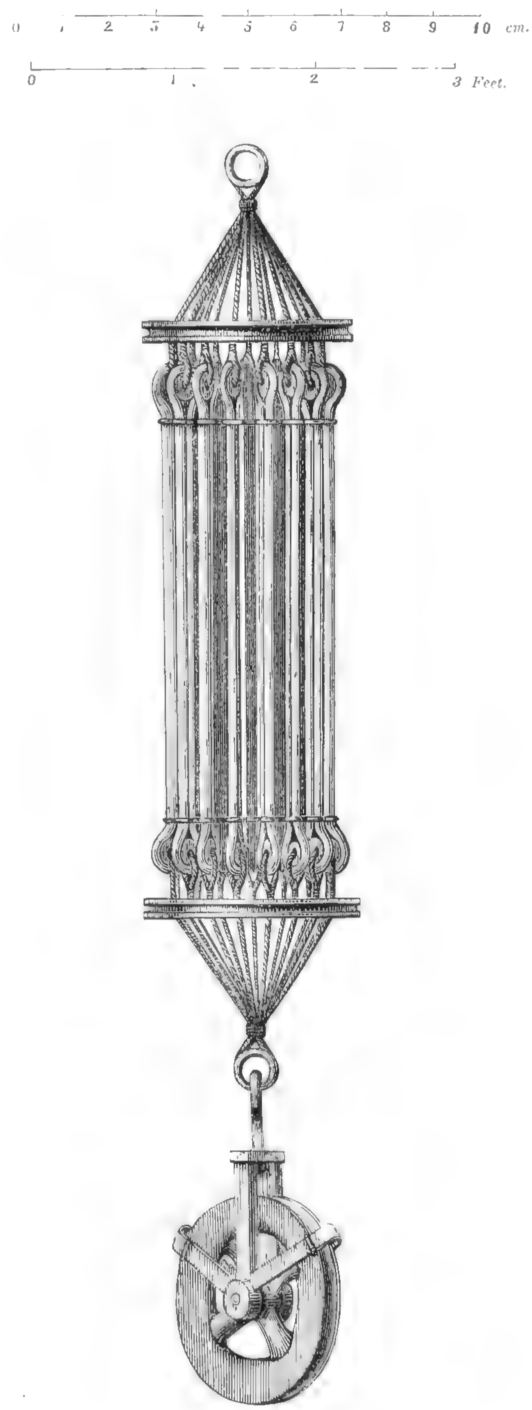


Fig. 10.

naar det er i Virksomhed, under Bagbords Storraa-Nok.

Hensigten med Accumulatoren er at kompensere Skibets Bevægelser op og ned i Søen, saaledes at Lodlinen

thimble is hooked on to a pendant, which will be afterwards described. When in use, the apparatus hangs suspended from the port main-yard-arm.

The most important function of the accumulator is to take off the suddenness of the strain on the line when

ikke bliver udsat for pludselige Ryk. Udvidelsen af Accumulatorens Stroppe tjener ogsaa til at angive Størrelsen af den Kraft, som gaar paa den.

Ved Afvejning i Land fandtes den Vægt, der svarede til hver Fods Udvidelse af en enkelt Strop, og derefter opsattes nedenstaaende Tabel, der dog selvfølgelig kun angiver omtrentlige Værdier. En Accumulator med 30 Stroppe brugtes til Bundskrabningerne.

Længde. Fod.	1 Strop.	15 Stroppe. Vægt i Pund.	30 Stroppe.
3	0	0	0
4	40	600	1200
5	61	915	1830
6	76	1140	2280
7	90	1350	2700
8	101	1515	3030
9	111	1665	3330
10	122	1830	3660
11	132	1980	3960
12	143	2145	4290
13	153	2295	4590
14	162	2430	4860
15	173	2595	5190
16	185	2775	5550
17	198	2970	5940
18	213	3195	6390
19	230	3450	6900

Ved $20^1/_2$ Fods Længde blev Stroppen sprængt.

Da Loddeblokken vejer sine 50 Pd., den største Loddevægt, som ovenfor anført, var 470 Pd., hvortil kommer Vandhenterens Vægt, ser man, at Accumulatoren, paa hvilken der i dette Tilfælde gik en Kraft af noget over 1000 Pd. før Lodderne kom i Vandet, ikke blev meget anstrengt i Forhold til hvad den kunde bære. Under Loddets Synken gaar der ikke stor Kraft paa Accumulatoren, derimod bevirker Lodlinens lange Overflade en saa betydelig Friktion mod Vandet under Ophalingen fra større Dybder, at Accumulatoren kan strækkes ud 0.m2 til 0.m3 (en halv til en hel Fod.)

Kautschukstroppene taaler godt Fugtighed, men angribes af fedtagtige Stoffe og lider vel ogsaa ved stadig Udsættelse for Vind og Vejr. Saasnart Lodningen var forbi, blev vistnok Accumulatoren strax firet ned i Vandet, men det kunde ikke altid undgaaes, naar den var udhalt under Raaen til Brug, at den for en kortere Tid kom i Røgen fra Skorstenen. Den i 1876 brugte Accumulator kunde ikke bruges den følgende Sommer. I 1877 anbragte jeg til Forsøg omkring Stropperne en Serk af Sejldug, der blev fastspigret rundt Kanten af øverste Træskive (se Fig. 1, Skrabe-Accumulatoren, og Titelbilledet samt Fig. 14) og var af samme Længde som Stroppene i Hvile. Ikke usandsynligt paa Grund af denne Beskyttelse holdt Accumulatorerne sig saa godt, at de kunde benyttes i 1878, dog i den sidste Tid forstærkede med nogle nye Reserve-Stroppe.

the vessel is rolling or pitching; but it is also valuable as indicating roughly the amount of the strain, by the greater or less extension of the straps.

By weighting one of the straps, I had found, before the Expedition left Norway on the first cruise, the amount of strain corresponding to its extension, for every successive foot. The results, which of course cannot but represent approximate values, are given in the following Table. An accumulator with 30 straps was used with the dredging-gear.

Length of Strap. Feet.	1 Strap.	15 Straps. Weight in Pounds.	30 Straps.
3	0	0	0
4	40	600	1200
5	61	915	1830
6	76	1140	2280
7	90	1350	2700
8	101	1515	3030
9	111	1665	3330
10	122	1830	3660
11	132	1980	3960
12	143	2145	4290
13	153	2295	4590
14	162	2430	4860
15	173	2595	5190
16	185	2775	5550
17	198	2970	5940
18	213	3195	6390
19	230	3450	6900

At twenty feet and a half the strap broke.

The weight of the sounding-block being 50 pounds, and that of our heaviest set of sinkers, as stated above, 470, to which must be added the weight of the water-bottle, the accumulator, which accordingly had to bear a strain of but little more than 1000 pounds before the sinkers reached the water, was not exposed to any severe test, considering the great strength of the straps. During the downward passage of the lead, there is very little strain on the accumulator; but when hauling in, the friction of one or two miles of cord in the water is so considerable, that the accumulator will be frequently stretched from half a foot to a foot.

The india-rubber springs stand wet and moisture well; they are, however, injuriously affected by grease and all kinds of fatty substances, and probably, too, suffer from continued exposure to wind and weather. Immediately after sounding, the accumulator was lowered into the shrouds; but when triced under the yard-arm for use, it was not always possible to keep it out of the smoke from the funnel. The accumulators provided for the first year's cruise, in 1876, had to be rejected on the next. To remedy this drawback, I tried, in 1877, the experiment of nailing round the rim of the upper disc a protective covering of canvass, of the same length as the unstretched straps (see Fig. 1, Dredge-accumulator, Frontispiece, and Fig. 14). Owing, probably, to this simple expedient, the accumulators kept in so good a condition as to admit of our using them

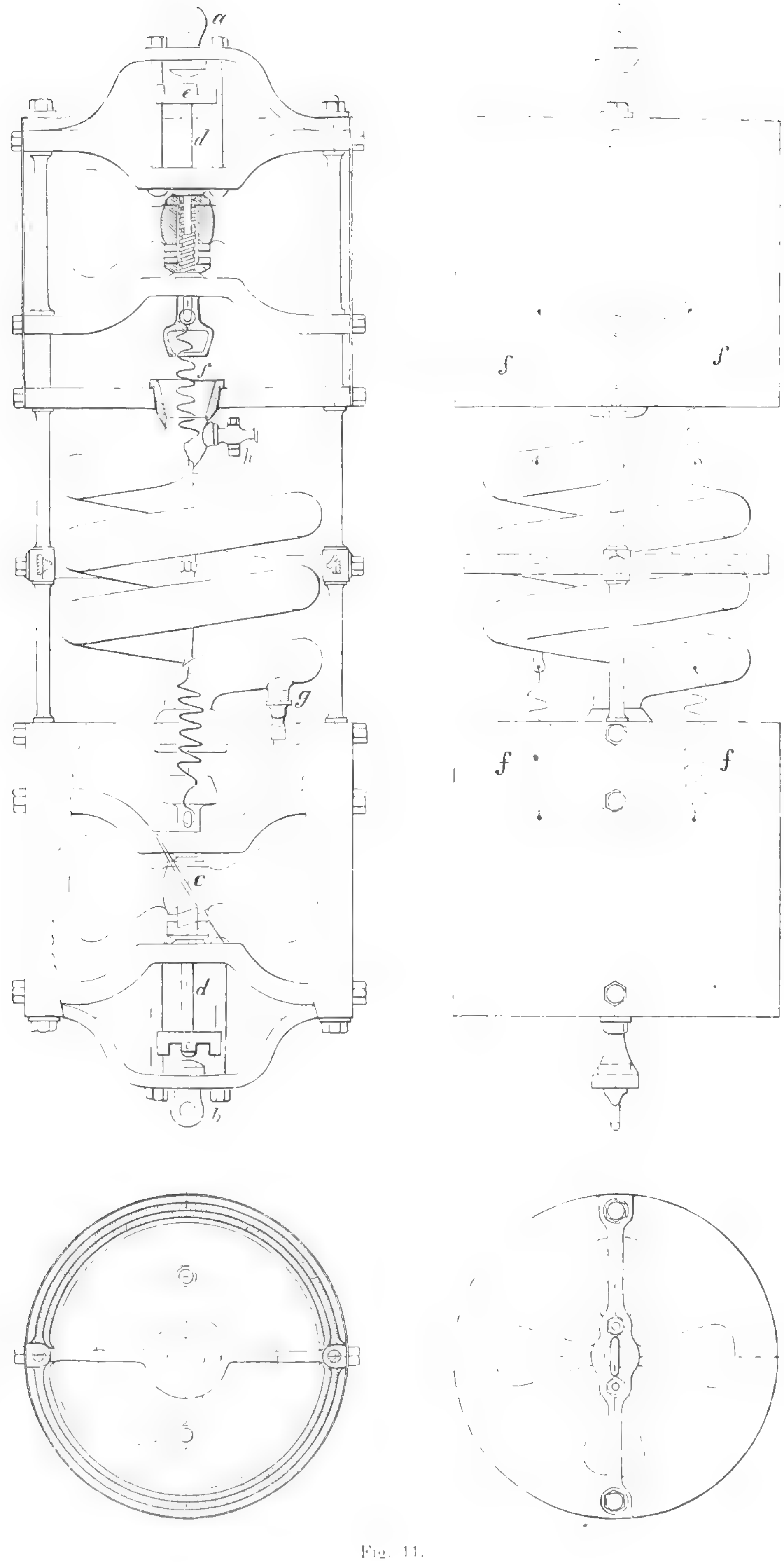


Fig. 11.

Thermometre. — De Dybvandsthermometre, der benyttedes paa vor Expedition, vare Casella-Millers, Buchanans (Kviksølvpiezometer) og Negretti og Zambras, den ældre og den nyere Model. Desuden gjordes Forsøg med Vand-Piezometre til Kontrolbestemmelser for de maalte Dybder. Alle disse Instrumenter ville blive beskrevne af Professor Mohn i hans Afhandling om Dybvands-Temperaturerne.

Vandhenter. — Paa vor Expedition anvendtes hovedsagelig den af mig dertil konstruerede, i Fig. 11 i $^1/_8$ af den sande Størrelse fremstillede Vandhenter. Instrumentet, der blev prøvet i Christiania før det blev antaget, blev brugt under den hele Expedition, saavel paa de større som paa mindre Dyb. Da Kemikeren havde stillet Fordring paa 5 Liter Vand, blev Apparatet meget stort, hvilket vistnok ikke generede Indhalingen i mærkelig Grad, men det gjorde det noget tungvindt at haandtere paa Dæk.

Vandhenteren er i Figuren fremstillet færdig til Udfiring. Tampen af Lodlinen hexedes i øverste (a) og Loddet i nederste Øjebolt (b). Under Udfiringen strømmer Vandet frit gjennem det, for Pladsens Skyld, spiralformig bøjede Rør, der var af Kobber og indvendig fortinnet. Samtidig løftes Propellerne op, saa at Taggerne i Underkant af Propelbosset c kommer klar af Taggerne i Muffen om Ventilstangen, og om de ikke skulde komme ganske klare, sker Propellens Omdrejning med Skraaplanerne, saaat Muffen og den gjennem samme gaaende Ventilstang d bliver staaende stille. Naar derimod Instrumentet under Indhivning bevæges opad, trykker Vandtrykket Propellerne ned, de drives rundt den anden Vej og tager Muffen med sig. Ventilstængerne, der styres af Tverstykkerne e og Ventilerne, der ere overtrukne med Kautschuk, skrues da mod Ventilsæderne i Enden af Røret, og naar de er næsten lukkede, glipper den sidste Skruegjænge i Ventilstangen ud af Skruegjængerne i Muffen og Spiralfjædrene (f) klappe da Ventilen i, og holder dem lukkede under Resten af Indhivningen, medens Propellerne og Mufferne gaa løse rundt den glatte Del af Ventilstangen og saaledes frembyde meget liden Modstand. Instrumentet lukkede sig efterat være indhalt 6 à 7 Favne. Skjærmene om Propellerne beskytter disse, saa at Instrumentet uden Skade kan ligge paa Bunden.

Da man ønskede at konstatere, om der var Overskud af Luft i de dybere Vandlag, blev der over Svikhullet (g) paa Røret paaskruet et gjennemboret Laag, og dette blev forenet med et i den ene Ende lukket Glasrør ved Hjælp af et Stykke Kautschukslange. Naar Vandet under Nedfiringen strømmede ind i Vandrøret, løb det ogsaa ned i

the year after (1878), strengthened, however, on the latter part of the cruise with a few spare straps.

Thermometers. — Of deep-sea thermometers, the Expedition was provided with the Miller-Casella, Buchanan's (mercury-piezometer), and Negretti & Zambra's (on the original and the improved construction.) Experiments were also made with water-piezometers, to control determinations of depth. These instruments will all be described by Professor Mohn, in his Memoir on the deep-sea temperatures.

The Water-Bottle. — For collecting water both from the bottom and intermediate depths, we made chief use, on each of the three cruises, of an instrument devised by myself, and tested in Christiania previous to the departure of the Expedition. Fig. 11 represents this water-bottle, one-eighth of the actual size. The apparatus having, as stipulated by Mr. Svendsen, chemist to the Expedition, to bring up 5 litres of waters, it was of course rather bulky; but this, though it made the instrument somewhat cumbersome to handle on deck, did not materially impede the heaving in.

In the figure, the water-bottle is shown ready to let go. The end of the sounding-line is shackled to the upper eyebolt (a), and the lead to the lower (b). On the downward journey, the water passes freely through the tube, which is of copper, tinned on the inside, and which, to save space, had been given a spiral form. Now, the pressure of the water will lift up the propellers, enabling the cogs in the under surface of the boss (c) to get clear of the cogs in the bush, through which passes the rod of the valve (d); and if not quite clear, the propeller will revolve *with* the inclined planes, the bush and the valve-rod remaining stationary as before. On the other hand, when the instrument, on being hauled in, is given an upward motion, the pressure of the water will force down the propellers, and they will then revolve in the opposite direction, carrying along with them the bushes. The valve-rods, which cannot revolve, being kept in position by the cross-pieces (e), will then, together with the valves, covered with india-rubber, be screwed against the valve-seats. When the valves are well-nigh closed, the last twist of the screw on the rod of the valve will slip out of the corresponding twist of the screw on the bush, and the spiral springs (f) instantly press down the valves and prevent the enclosed sample of water from escaping, the propellers and the bushes being left to revolve independently round the flush portion of the rods, thus affording very little resistance on the passage to the surface. The instrument closes on being hauled in 6 or 7 fathoms. The shields round the propellers serve to protect them from damage when the instrument is lying on the bottom.

With a view to ascertain whether the proportion of air were really greater in the deeper strata of the ocean, a perforated cover was screwed over the spigot-hole (g), and connected, by means of a short piece of india-rubber hose, with a glass tube, sealed at one end. Now, when the water on the downward passage of the instrument entered

Glasrøret, af hvilket saaledes den atmosfæriske Luft blev udjaget. Naar Instrumentet kom ombord, endevendtes det, saaledes at Kranen *h* kom ned og Glasrøret op. Man bevægede nu Vandhenteren lidt frem og tilbage med den øvre Ende, og hvis der havde været Overskud af Luft, maatte denne have arbejdet sig op, og vist sig i Toppen af Glasrøret. Dette viste sig imidlertid i ethvert Tilfælde fuldt af Vand lige til Tops, og blev derfor i den senere Tid ikke paasat.

Til mindre Dybder, og naar man ikke behøvede at standse Udfiringen, benyttedes en mindre Vandhenter konstrueret af Professor *Ekman* i Stockholm. Dette Apparat er fremstillet i Fig. 12. Det bestaar af en i begge Ender aaben Cylinder *c*, der har en Brem rundt om den øvre Kant. Denne Cylinder løber op og ned langs tre[1] Styrestænger *d*, hvis øvre Ender er forbundne med et Tværstykke, og de nedre Ender er fæstede til en Bund, der har en med Fedt eller Guttapercha fyldt Udskjolpning rundt om, i hvilken Cylinderens nedre Kant passer. I denne Bund er ogsaa en Udtapningskran. Fra Midten af Bunden staar op en Stang, der bærer en Skive med Kanter af ombøjet Kautschuk, og som lukker Cylinderen foroven, naar den er sluppet ned. I denne Skive er et Svikhul, lukket med en Prop. Cylinderen hukes med en Sliphage *a* i det øvre Tværstykke mellem Stængerne, og denne Hage holder da Cylinderen oppe, medens Apparatet løftes over og langs Skibssiden, men naar man lader det falde i Vandet, løftes Cylinderen lidt af Vandtrykket under Bremmen og Sliphagen falder ned. Vandtrykket holder da Cylinderen fremdeles oppe, saalænge Instrumentet synker raskt, men idet man standser Udfiringen eller ved Bunden, falder den ned og indeslutter Vandet. Hagen *b* griber fat under Bundstykket og hindrer Cylinderen fra at løfte sig mere, naar den engang er faldt ned.

[1] I Figuren er for Tydeligheds Skyld kun tegnet to.

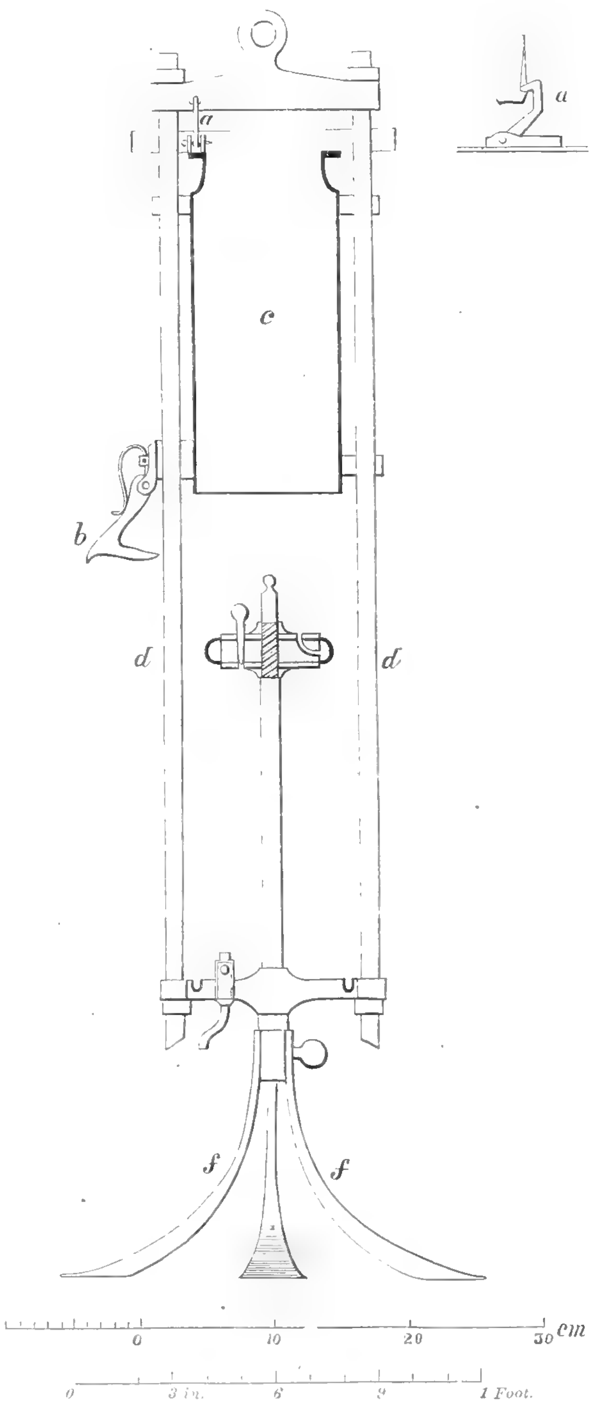


Fig. 12.

the spiral copper tube, it also flowed into the glass tube, expelling the atmospheric air. So soon as the instrument came on board, it was inverted, the stopcock (*h*) pointing down and the glass tube up. The upper end of the apparatus being then moved gently backwards and forwards, the surplus of air, had any such existed, must obviously have forced its way upwards, and have appeared, in the form of bubbles, at the top of the glass tube, which, however, was invariably found to be full of water; and hence we ceased to attach it when the fact would no longer admit of doubt.

For moderate depths, and when not obliged to check the line in veering out, we used a smaller water-bottle, constructed by Professor *Ekman* of Stockholm. This instrument is represented in Fig. 12. It consists of a brass cylinder (*c*), open at both ends, and with a flange round the upper rim. The cylinder slides up and down 3[1] metal guides, the upper ends of which are connected by a beam, the lower end being fixed to a circular bottom-piece, having a grooved rim filled with grease or guttapercha, into which the cylinder fits. The bottom-piece is also provided with a stopcock; and, projecting upwards from the centre, extends a stout rod, bearing a metal disk, the rim of india-rubber, which serves to close the top end of the cylinder, on the latter having slid down the guides. In the disk is a spigot-hole, stopped with a plug. The cylinder is attached to the beam, between the guides, by means of a slipping-hook (*a*), which keeps it suspended when lifting the apparatus and lowering it over the ship's side; but on its reaching the water, the pressure against the under surface of the flange slightly raises the cylinder and slips it off the hook. Meanwhile, the pressure of the water will retain the cylinder at the top of the instrument, the descent being sufficiently rapid; but on checking the line, or the instant the machine touches the bottom, it will slide down and shut in a sample of

[1] To avoid apparent complexity, only two of the guides are shown in the figure.

De nedentil paasatte Jernblade *f* stoder mod Bunden og hindrer, at Kranen bliver fyldt med Mudder. Til vort Brug anbragtes istedetfor disse en fast Jernstang med Øjebolt i den nedre Ende, i hvilken Ror-Loddet indhexedes. Apparatet rummede 2 Liter Vand.

Under de før antydede Omstændigheder er Apparatet særdeles hensigtsmæssigt og Tætningen paalidelig, men kommer noget i Vejen under Nedfiringen, maa hele Operationen gjøres om igjen, og dertil kommer, at Bremmen tilligemed øverste Lukningsskive frembyder en ikke uvæsentlig Modstandsflade under en længere Indhivning.

Forberedelser til Lodning. Lodlinen, 3000 Favne lang, var oprullet paa den agterud om Bagbord i Dækket fastskruede Dækrulle, der sees i Fig. 1, 2 og 14. I Fig. 13 er denne vist tydeligere. Rullens Bom var 0.^{m}627 (2 Fod) lang, 0.^{m}157 (6 Tom.) tyk og af Træ. De cirkelformede Sideflader var af tykke, galvaniserede Jernplader, paa den indre Side plane, paa Ydersiderne forstærkede ved dobbelte Lag af Jernplader. Deres Diameter var 1.^{m}098 (3 Fod 6 Tom.) og deres Kanter var afrundede, saa at de frembød en glat, ringformig Flade af omtrent 2.^{cm}6 (en Tommes) Diameter. Paa Bagbord Side var anbragt en Svejv af 0.^{m}31 (1 Fods) Længde med Træhaandtag. Stativets tvende Dele var nedentil forbundne med Jernstænger, og det hele hvilede paa et Par langskibs løbende Bjælker, gjennem hvilke Stativet var skruet fast til Dækket.

Tampen af Lodlinen toges fra Rullen og manedes gjennem Fodblokken paa Agterkant af Hytten (Fig. 14.) Denne Blok var lidt mindre end Loddeblokken, og Skiven solid, men forøvrigt af samme Konstruktion som denne. Derfra manedes Lodlinetampen videre gjennem Loddeblokken, der hang under Accumulatoren. Accumulatoren var i sin øvre Ende fæstet til et *Topreb*, hvis anden Ende var fastgjort over Godset paa Storsalingen (Fig. 14.) Med en firskaaren Talje haledes nu Accumulatoren ud paa sin Plads under Bagbords Storraa-Nok. Storraaen brasedes saaledes, at Accumulatoren kom omtrent for Midten af Loddebroen, og blev i denne Stilling forstøttet med Braser, Toplenter og Rakke. Lodlinen ihexedes øverste Øjebolt i Vandhenteren, eller Ringen i Rørloddet, eller Ringen i Røret til Baillie-Maskinen, efter Omstændighederne. Benyttedes Willes Vandhenter, hexedes Rørlod eller Baillie-Maskinen i dennes nederste Øjebolt. Disse Forberedelser blev truffet, medens Fartøjet endnu var i Gang. De følgende Manøvrer, der udførtes dels for at holde Fartøjet saavidt muligt paa Plads under Lodningen, dels for at faa

water. Once down, the cylinder is kept in position by a hook (*b*), which catches on the under surface of the bottom-piece. The iron fenders (*f*) at the lower end of the instrument serve to protect it when striking the bottom, and prevent mud or rubble from fouling the stopcock. In lieu of the fenders, we substituted an iron rod, having at the lower end an eye-bolt, to which the tube-lead was attached. The apparatus brings up about 2 litres of water.

Properly used, the Ekman water-bottle gives every satisfaction. There is no leakage; but should any mishap occur in veering, the whole operation will have to be repeated; moreover, the flange of the cylinder and the disk at the top offer considerable resistance in hauling up the instrument.

Preparations for Deep-sea Sounding. — The sounding-line — length 3000 fathoms — was wound on the port side of the after-deck on a large, strong reel, secured by screws (Figs. 1, 2, and 14) to the deck. Fig. 13 conveys a clearer idea of the arrangement. The barrel of the reel was of wood, 2 feet $3^3/_4$ inches long by $6^3/_{16}$ inches in diameter, the two terminal disks being of thick, galvanized sheet-iron, strengthened on the outer surface by a double plating of the same material. They measured 3 feet $7^1/_4$ inches in diameter, and were rounded at the circumference, so as to give them a smooth annular rim, about an inch broad. At the port end, the reel had an iron lever-arm, 1 foot in length, with a wooden handle. The two supports of the frame were connected underneath by means of iron stays, the whole apparatus being made to rest on a couple of beams running fore and aft, through which the frame was screwed to the deck.

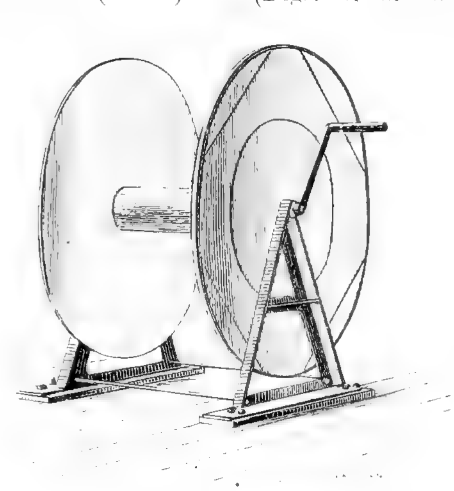


Fig. 13.

The end of the line was run off the reel and rove through the leading-block on the after part of the round-house (Fig. 14.) This block was a trifle smaller than the sounding-block and had a solid sheaf, though in other respects similarly constructed. From thence the line was rove through the sounding-block, which hung beneath the accumulator. This apparatus was attached to a strong pendant, made fast above the gear of the main cross-trees (Fig. 14), and by means of a gun-tackle purchase hauled out under the port main yard-arm, the yard being trimmed so as to bring the accumulator as near as possible abreast of the sounding-bridge, and kept in position by the braces, topping-lifts, and trusses. The line — according to the nature of the operation — was next shackled to the upper eye-bolt of the water-bottle, the ring of the tube-lead, or the ring of the tube of the Baillie machine. When using Wille's water-bottle, we hung the sounding-instrument — the tube-lead or the Baillie machine — to the lower eye-bolt. These preparations were made with the vessel steaming ahead; the subsequent manœuvres, for keeping the ship in position

Loddet i Bund, udførtes samtidig med Fartøjet og med Apparaterne paa Dæk.

Manøvre med Fartøjet. Ved Ankomsten til Loddestationen lagdes Fartøjet med Stevnen ret imod Vinden og stoppedes. I denne Stilling søgte man nu at holde det paa samme Plads hele den Tid, Loddet behøvede for at komme til Bunds. Ved afvexlende at lade Maskinen gaa langsomt forover, naar Fartøjet begyndte at sakke, og stoppe, naar Lodlinen begyndte at vise agterover, opnaaedes i Regelen Hensigten, idet Skruevandet gav tilstrækkeligt Tryk,

and for sinking the lead to the bottom, we carried out together, handling the vessel and the deep-sea apparatus simultaneously.

Handling the Ship. — On arriving at a sounding-station, the vessel was put head to wind and her way deadened. In this position we tried to keep the ship as near as possible stationary during the passage of the lead to the bottom. By alternately starting the engine as soon as the vessel had got sternway and stopping when the line began to point aft, we generally managed to gain our object, the water thrown back by the screw acting on the rudder

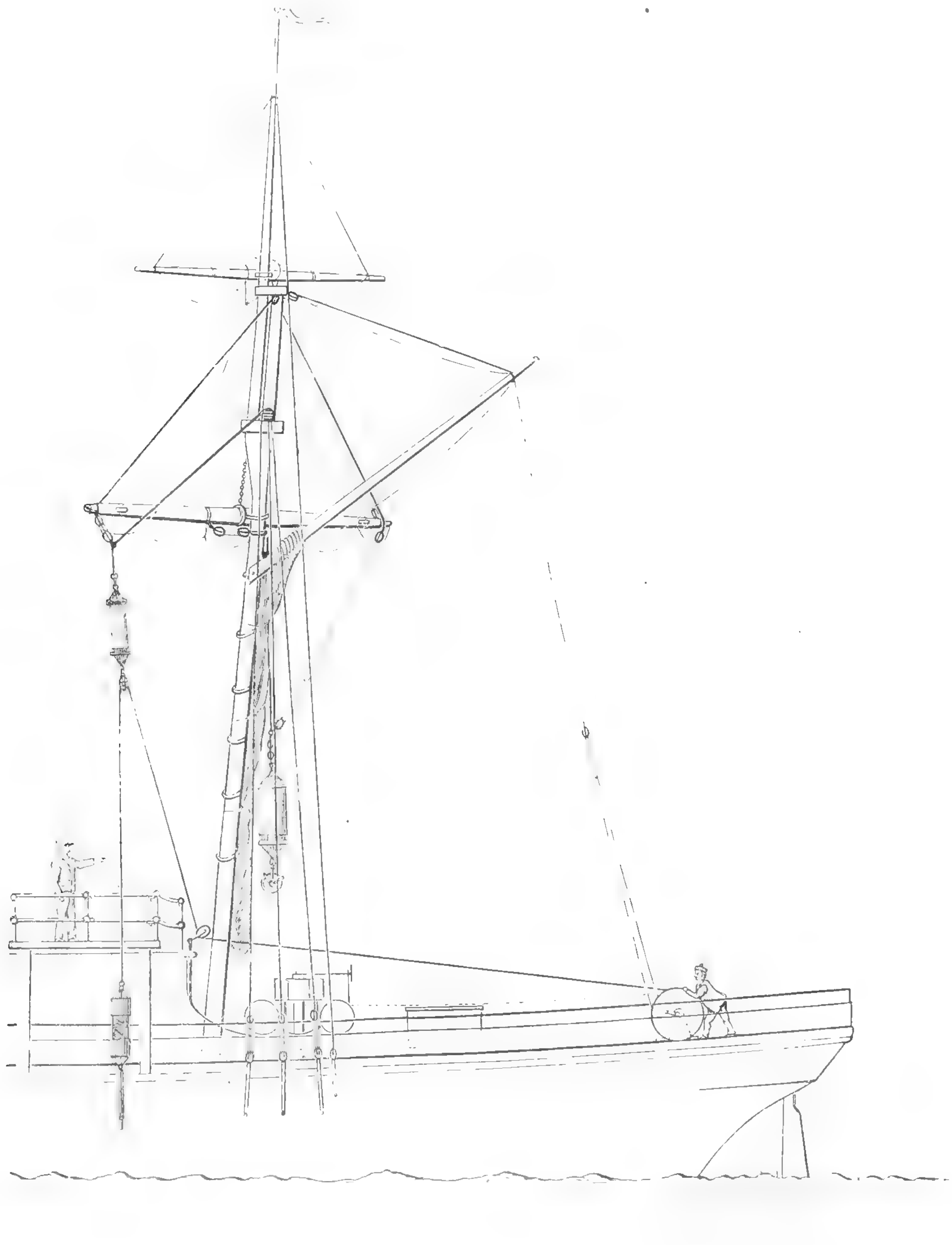


Fig. 11.

til at Roret kunde virke og benyttes til at støtte for Affald til den ene eller den anden Side. I løj Bris sattes undertiden bakt Fortopsejl, hvorved opnaaedes større Modstand mod Skruens Virkning, saaledes at Maskinen kunde gaa hurtigere forover og med mindre eller ingen Afbrydelse, hvorved Styringen blev saameget mere virksom. Desuden kunde Fartøjet ogsaa styres ved at brase Topsejlet.

Naar Vinden var meget svag, Søen rolig og Dybden ringe, kunde Lodningen udføres ved at lægge Fartøjet tvers paa Vinden med Lodlinen til Luvart.

Med stiv Kuling og høj Sø var det selvfølgelig nødvendigt at anvende stor Paapasselighed for at kunne holde Skibet i den rigtige Stilling med Stevnen mod Vinden. Det var under saadanne Omsændigheder ofte ikke muligt for Rorgjængeren med det langsomt virkende Styreapparat at undgaa, at Bougen faldt af til den ene eller til den anden Side. Et begyndende Affald til Styrbord kunde i Regelen standses med Styrbord Ror og et Par Slag fuld Fart forover, der kunde give Roret Drejningskraft, uden at Skibet begyndte at skyde over Stevn. Hjalp ikke dette, gaves derpaa fuld Fart agterover, hvorved Skruen drejede Agterskibet til Styrbord — denne Grund var væsentlig bestemmende for at lade Lodningen foregaa om Bagbord — og fjernede dette fra Lodlinen, og derefter fuld Fart forover med Styrbord Ror, indtil man fik Stevnen op i Vinden igjen og Lodlinen lodret.

Besværligere blev Manøvren, naar Skibet, uagtet al anvendt Forsigtighed, faldt med Bougen Bagbord ud over Linen. Dersom det da ikke lykkedes ved enkelte Slag forover og agterover og Skiftning af Roret at faa Vinden ind om Bagbord, saa man med Fart forover og Styrbords Ror kunde komme op i Vinden med Linen klar af Siden, var der intet andet at gjøre end med afvexlende fuld Fart forover og agterover at dreje Skibet helt rundt om Lodlinen Bagbord over, indtil man atter kom op med Stevnen mod Vinden, og Linen visende lodret.

Man kunde ogsaa i ikke altfor svær Sø med Fordel lægge Agterenden mod Vind og Sø, og med Lodlinen til Luvart holde Fartøjet paa Plads med Skruen gaaende agterover, idet Agterenden i saadant Fald altid søger op imod Vinden.

Lodning med Rør-Lod. Loddet (med Vandhenter) løftedes, saasnart Skibets Fart var standset, ud over Loddebroen, og firedes, idet en Mand drejede Svejven paa Rullen, omtrent en Favn ned. Dybvandsthermometerne sattes fra Loddebroen fast paa Lodlinen. Ved Rullen stod 2 Mand, med Læderhandsker paa Hænderne, paa hver sin Side af denne og trykkede med Magt paa Sidefladernes afrundede Kanter. Alt var nu færdigt til at „Lade gaa". Idet den kommanderende Officer fra Loddebroen gav Ordren: „Lad gaa"! slippedes Svejven paa Rullen løs, Loddet og Lodlinen tog Fart; og Rullen drejede sig rundt. Det er dette Øjeblik, der er fremstillet i Fig. 14. De to Mænd med Læderhandskerne regulerede ved sit Tryk paa Rullen Bevægelsen saaledes, at den blev saa jevn som muligt, hvad der

with sufficient force to give steerage way and prevent the ship from falling off. In a light wind we sometimes set the fore topsail aback, and thus, by occasioning greater resistance to the action of the screw, enabled the engine to work quicker a head and with little or no interruption, which made the steering more effective. The ship could be steered, too, by bracing the topsail.

If there was very little wind and no sea, we could sound, in comparatively shallow water, with the vessel laid beam to wind and the line to windward.

In a stiff breeze and with a heavy sea running, great care and attention were obviously needed to keep the ship in position with her head to the wind; nay, the helmsman, owing to the necessarily tardy action of the steering-gear, found it impossible to prevent her from now and again paying off. If she fell off to starboard, we generally managed to bring her up by putting the helm a-starboard and starting the engine ahead, a few strokes of the screw being sufficient for the rudder to act, without getting way on the ship. This failing, we gave her full speed astern, upon which the action of the screw, bringing the stern of the vessel to starboard, kept it clear of the sounding-line (the certain result of this manœuvre was indeed our main reason for carrying on the sounding operations from the port side), and then steamed full speed ahead till the ship was again head to wind and the line pointed right up and down.

When the vessel, in spite of every precaution, had fallen off with her head to port across the line, the difficulty of bringing her to was much greater. In that case, if we failed by a few strokes of the screw ahead and astern, and by shifting the helm, in getting the port side to windward, so as, on starting the engine ahead, with the helm a-starboard, to bring the ship head to wind and clear of the line, our only resource lay in working her head to port round the line, by steaming full speed alternately ahead and astern, till we had again got her head to wind, with the line right up and down.

In comparatively moderate weather, we found it a good plan to lay the ship stern to wind and sea, with the line to windward, and keep her in position with reversed engines, the stern then invariably working up against the wind.

Sounding with the Tube-lead. — As soon as the vessel had lost her headway, the lead (with the water-bottle attached) was lifted over the sounding-bridge, and then lowered about a fathom, a man turning the handle of the reel. The deep-sea thermometers were fastened to the line from the bridge. Two men, their hands protected by leather gloves, stood one on either side of the reel, and pressed against the annular rim of the sheet-iron disks. Everything was now ready for the operation. At the moment the officer in charge, from his station on the sounding-bridge, gave the word to let go, the man grasping the handle of the reel let go his hold, and the lead immediately dropped, dragging after it the line, which, in running out, caused the reel to revolve. This is the stage of the operation re-

er af Vigtighed for Nøjagtigheden af den følgende Beregning af Dybden. Det Stykke af Lodlinen, der er mellem Rullen og Fodblokken, maa altid have en passende Stramning, saaat Linen ikke under Bevægelsen slaar Bugter, der kunde bringe den til at kaste sig om en eller anden fremstaaende Gjenstand og derved foraarsage Havarier eller en pludselig Standsning af Lodlinens Bevægelse. Denne Bremsning fordrer derfor baade Opmerksomhed, Kraft og Øvelse.

I 1877 forsøgte jeg en mekanisk Bremse paa Rullen, men den viste sig upraktisk og anvendtes kun nogle Gange. Naar Skibet løfter sig paa Søen, rives Linen af Rullen med stor Kraft, og naar det atter sænker sig, formindskes Loddets Drag, ja ophæves undertiden næsten for et Øjeblik. Disse uafladelige Forandringer føles strax, naar man bremser med Haand, og med nogen Øvelse vænner man sig til at bremse netop det nødvendige, men med den mekaniske Bremse viste det sig ugjorligt at følge Forandringerne, der ikke føltes gjennem Apparatet.

Ved Dybder, der ikke oversteg 900 til 1000 Favne, mærkedes bedst, at Loddet slog i Bund, derved, at man lod Linen løbe ganske løst gjennem Haanden, og man følte da en pludselig Aftagen i Udløbshastigheden. Man kunde ogsaa tydelig se det derved, at Linen mellem Fodblokken og Rullen lagde sig pludselig flad ned paa Dækket. Saasnart over 700 Favne var ude, var den Bremsning, der udfordredes for at holde Linen stram, kun ringe. I nogle faa Tilfælder, i hvilke der blev loddet paa 1100 til 1200 Favne med Rørlod alene, viste det sig, at det ikke var muligt at iagttage det Øjeblik, da Loddet kom i Bund. Linen vedblev at løbe ud paa Grund af sin egen Vægt med en Hastighed, der ikke var synligt forskjellig fra den Hastighed, hvormed den løb med Loddet som Tillægsvægt. Under saadanne Omstændigheder loddedes om igjen med Baillie-Maskine, dersom det ansaaes fornødent at faa et nøjagtigt Lodskud. Med Rørlod og Willes Vandhenter sammen kunde der faaes gode Lodskud paa over 1100 Favne, som et Forsøg paa Station 247 viste. Her gav nemlig Baillie-Maskinen 1120 Favne, medens Rørlod med Vandhenter gav 1124 Favne.

Bestemmelse af Dybden. Da Lodlinen for de større Dyb kun var mærket for hver 100 Favne, maatte det nøjagtige Favnetal søges ved særegne Observationer og Beregninger. Den fra først af brugte Fremgangsmaade var følgende. I det Øjeblik, Loddet gik i Vandet, og naar et Hundrede-Favne-Mærke gik i Vandet, raabtes „Nu" og Klokkeslettet noteredes i Loddejournalen paa nærmeste Sekund. Forat give Noteringerne større Sikkerhed, varskoedes af Folkene ved Rullen altid i Forvejen „Mærke", naar et af Mærkerne gik af Rullen. I det Øjeblik Loddet var i Bund, raabtes „Bund" og det tilsvarende Klokkeslet noteredes. Af Rækken af de under hverandre noterede Klokkeslet toges første Differents. Disse Tal stige med Dybden, idet Udløbshastigheden aftager med Længden af den gjennem Vandet løbende Lodline. Dernæst beregnedes

presented in Fig. 14. The two men with leather gloves endeavoured, by pressing upon the reel, to keep the motion as uniform as possible, this being an essential condition for accurately computing the depth. When veering, the line between the reel and the leading-block must be kept sufficiently taut, to prevent its running out in bights, that might catch on some projecting object, and thus occasion damage, or possibly a sudden stoppage of the line. Hence, skilful braking requires care, practice, and physical strength. In 1877 I tried a mechanical brake; it proved, however, inefficient, and was used only a few times. When the vessel heaves, the line is run off the reel with great violence, and on her plunging into the trough of a sea, the drag of the lead becomes greatly diminished, nay, for a moment may be taken off altogether. These constant alternations are instantly felt when the braking is done by hand; and with some little practice, the brakesmen can calculate to a nicety the needful amount of pressure, whereas with the mechanical brake we found it impossible to follow the changes, which could not be felt through the machine.

In depths not exceeding 900 or 1000 fathoms, the best way of determining the exact moment when the lead struck the bottom, was to let the line run loosely through the hand, when a sudden disminishment of velocity would be felt. Nay, it could be distinctly *seen*, the line between the leading-block and the reel becoming all at once slack and dropping down on the deck. Having veered to a depth of 700 fathoms, there was no great need of braking to keep the line taut on the remainder of the downward journey. In some few instances, when sounding in from 1100 to 1200 fathoms with the tube-lead alone, we found it impossible to tell exactly when the lead touched the bottom. The line went on running out by its own weight only, and moreover, with a velocity that did not sensibly differ from that given it by the additional weight of the lead. Hence, when accuracy of measurement was the chief desideratum, we had to sound again, and with the Baillie machine. Sent down along with Wille's water-bottle, the tube-lead gave good results, as shown at Station 247. Here, the Baillie machine indicated a depth of 1120 fathoms, and the tube-lead used with Wille's water-bottle, 1124.

Determination of Depth. — The line for deep-sea soundings being graduated into hundreds of fathoms, the exact depth had in each case to be computed from special observations. Our mode of procedure was, at first, as follows: — The moment the lead entered the water, as also one of the slips of bunting on the line, an officer called out, and the time to a second was entered in the sounding-journal. To attain greater accuracy, the brakesmen had to give timely notice for every slip of bunting run off the reel; the instant the lead struck the bottom, the officer gave the word, and the time was entered in the journal. From the series of entries was computed the first difference, or set of intervals. These figures increase with the depth, the velocity diminishing with the length of the line running out through the water. The second difference of the series

2den Differents af Rækken, hvilken, fraregnet de uundgaaelige mindre Variationer i Udløbshastigheden, viste sig at være paa det nærmeste constant. Med denne anden Differents beregnedes Størrelsen af Tidsintervallet for Udløbet af det sidste observerede Hundredefavnemærke til det næste Mærke, inden hvilket 100 Favne-Interval altsaa Loddet kom i Bund. Ved Hjælp af dette Tal og den mellem Udløbsøjeblikket for det sidst observerede Hundrefavnemærke og Øjeblikket for „Bund" forløbne Tid beregnedes ved simpel Proportion, hvor mange Favne der vare udløbne mellem de tilsvarende Øjeblikke. Denne Længde, tillagt Numeret for sidste observerede Mærke, bliver Lodskuddet eller Dybden.

Som Exempel anføres her et Uddrag af Loddejournalen, der tillige viser dennes Indretning.

No. 129.		Dato	1877 Juni 20
		Bredde	67° 40'.5 N.
Klokkeslet	4h 30m p. m.	Længde	6° 42' E. Greenw.
Vind	NE.	Lufttemperatur	5°.9
Styrke	3	Overflade do.	6.8
Vejr	Skyet.	Dybde	709 e Fv.
Sø	NE. 4	Bund	Brun Ler
Vægt	112 Pd.	Karakter	Godt.

Favne.	Tid.			Interval.		2den Diff.
	T.	M.	S.	M.	S.	Sec.
Lad gaa	4	46	30	1	11	
100		47	.41	1	13	2
200		48	51	1	30	17
300		50	24	1	42	12
400		52	6	1	55	13
500		54	1	2	3	8
600		56	4	2	9	6
700		58	13	0	15	
Bund		58	28			

For Intervallet 700 til 800 Favne beregnes Udløbstiden til $2^m\ 9^s + 6^s = 2^m\ 15^s = 135^s$. Altsaa faaes Proportionen:

135^s : 100 Favne = 15^s : 11 Favne.

Efter dette skulde Dybden være 711 Favne. Ved Udmaaling af det Stykke af Lodlinen, der var i Vandet i det Øieblik, Loddet slog i Bund, over 700 Favne, efter den nedenfor beskrevne Methode, fandtes 9 Favne, altsaa Dybden 709 Favne, som opført i Loddejournalen.

Nøjagtigheden af Tidsintervalmethoden beror, som man ser, ganske paa den Grad af Jevnhed i Bevægelsen, som kan tilvejebringes ved Bremsningen. Resultatet tiltrænger derfor en Kontrol ved andre Methoder, saaledes som det stadig blev gjort paa vor Expedition. Ved at sammenligne Resultaterne af de forskjellige Methoder viser det sig, at Tidsintervalmethoden næsten altid giver for store Tal.

was calculated from the first, and the figures thus obtained, if we except all minor variations in velocity, proved very nearly constant. From the second difference was computed the interval that would have elapsed, had the depth been sufficient, ere the slip of bunting next in succession to that last run off could have entered the water, and within which the lead had accordingly reached the bottom. Then, with the figure thus found and that denoting the time between the moment when the last slip of bunting reached the water and that at which the lead struck the bottom, was computed, by simple proportion, the odd number of fathoms, which, added to the length on the slip last run off the reel, gave the true sounding, or depth.

The following is an extract from the sounding-journal, showing its mode of arrangement.

No. 129.		Date	1877 June, 20th.
		Lat.	67° 40' 5 N.
Time	4.30 p. m.	Long.	6° 42' E.
Wind	NE.	Temp. of Air	5° 9
Force	3	Do. of Sea	6° 8
Weather	Cloudy	Depth	709 Fathoms.
Sea	NE. 4	Bottom	Brown Clay.
Weight	112 pounds	Character	Good.

Fathoms.	Time.			Interval.		2nd Diff.
	h.	m.	s.	m.	s.	s.
0	4	46	30	1	11	—
100	4	47	41	1	13	—
200	4	48	54	1	30	2
300	4	50	24	1	42	17
400	4	52	6	1	55	12
500	4	54	1	2	3	13
600	4	56	4	2	9	8
700	4	58	13	0	15	6
Bottom.	4	58	28			

Now, the interval from 700 to 800 fathoms is found to be 2m 9s + 6s = 2m 15s = 135s; and hence

135s : 100 fathoms : : 15s : 11 fathoms.

This would make the depth 711 fathoms. Measuring by the method described below the part of the line which, in addition to the 700 fathoms, had run out when the lead struck the bottom, we get 9 fathoms, and thus a depth of 709 fathoms, the depth enteréd in the sounding-journal.

As regards the accuracy of the method of computation by time-intervals, it is obvious that this must be wholly dependent upon the degree of uniformity attainable in braking. The results will have in each case to be tested by some other method; and this was invariably done on the Norwegian Expedition. On comparing together the results of the different methods, the figures obtained

En anden Methode var at tage Tidsintervaller under Indhivningen af Lodlinen, idet man lod Indhivningsmaskinen gaa saa jevnt som muligt. Herved fik man bestemt det Tidsrum, Maskinen brugte for at tage ind 100 Favne saavelsom det Tidsrum, den med samme Hastighed tog ind Overskuddet over sidste Hundredefavnemærke, og Længden af det sidste kunde saaledes bestemmes ved simpel Proportion. Med jevnt Damptryk og jevn Damptilførsel til Maskinen, hvilke er lettere at holde end jevn Bremsning især i urolig Sø, giver denne Methode gode Resultater. Dens Resultater antoges, naar den anvendtes med de nævnte Forudsætninger, som de definitive, forsaavidt ikke den i det følgende beskrevne Methode kom til Anvendelse. De Lodskud, som i 1876 falde paa Dybderne mellem 100 og 300 Favne, beregnedes udelukkende efter den sidst beskrevne Methode.

Den tredie Methode, der er den sikreste, indførtes først i 1877. Idet Loddet løftedes af Bunden, viste Virkningen af dets Vægt sig paa Accumulatoren, der pludselig strakte sig noget ud. En Mand, som stod klar ved agterste Spiltap, greb i dette Øjeblik paa givet Signal med den ene Haand om halende Part af Linen over Midten af Tappen, og fulgte med Linen, idet denne rulledes op paa Rullen, agterover en paa Dækket afsat Længde af 3 Favne. Naar han kom til agterste Mærke, slap han Linen og raabte „En". Næste Mand greb da fat om Linen ved Tappen, og naar han kom til agterste Mærke, raabte han „To" o.s.v. Idet det sidst udløbne Hundredefavnemærke kom i Vandskorpen varskoedes „Stop". Den søgte Længde af Lodlinen fandtes saaledes ved direkte Udmaaling med en Nøjagtighed af en Brøkdel af en Favn.

Ved de mindste Dybder, for hvilke Lodlinen var mærket for hver 10de Favn, bestemtes det enkelte Favnetal i Regelen ved direkte Udmaaling, dels alene, dels som Control for Tidsintervaller med Indhivningsmaskinen.

Lodning med Baillie-Maskinen. Denne blev gjort i Stand paa Agterdækket lige agtenfor Hytten som før forklaret. Saasnart de nødvendige Forberedelser med Lodlinen og Accumulatoren, de samme som ovenfor beskrevne, var færdig, hexedes Lodlinen til Ringen i Baillie-Maskinen eller til øverste Øjebolt i Vandhenteren og i dette Tilfælde nederste Øjebolt i Vandhenteren til Ringen paa Røret. Linen stivhaltes og lagdes rundt Tapperne paa Indhivningsmaskinen. Med denne løftedes nu, naar Fartøjet var stoppet, det hele over Rækken mellem Hytten og Storvantet (Fig. 14) og firedes ned i Vandet for ikke at komme i Svingning og Berøring med Skibssiden under Fartøjets Bevægelser. Dybvandsthermometrene fastgjordes derefter paa Linen 1 à 2 Favne over Vandhenteren eller Lodderne, hvorpaa man med Indhivningsmaskinen udfirede raskt 200 eller 300 Favne. Maskinen standsedes, Stopper paasattes i Forhaand paa Hyttedækket, Linen kastedes af Spiltapperne og rulledes

from computation by time-intervals almost always proved too high.

Another method practised was to measure time-intervals during the winding in of the line, due care being taken to regulate with the greatest nicety the working of the donkey-engine. We could thus determine both the time required for bringing in 100 fathoms and that needed for hauling in the surplus portion of the line run out after the last 100 fathom slip had reached the water, the length of which was then computed by simple proportion. With an equable steam pressure and an equable supply of steam, which is much easier to keep up, more especially in a rough sea, than uniform manual braking, this method will give good results; and hence, when carefully obtained, we regarded such as final, save when the method described below was also had recourse to. The soundings taken in 1876 that embrace depths from 100 to 300 fathoms, were computed exclusively by this method.

The third method, which is the most trustworthy, was not adopted till 1877. On the lead being lifted from the bottom, its weight tells upon the accumulator, which instantly yields a little to the strain. Then, at a given signal, a man, stationed for the purpose at the after drum of the donkey-engine, laid hold of the line as near as may be above the middle of the drum, and while the leading part was being wound on the reel, went aft with it for a distance of 3 fathoms, which had been marked off on the deck, and thereupon let go, calling out as he did so — „One"! Another man then caught hold of the line above the drum, went the same distance aft, and cried — „Two"! and so on in like manner. The instant the 100 fathom slip last run out appeared above the surface of the water, a man called out — „Stop"! Thus, by actual measurement, we found the length of the line within a fraction of a fathom.

Soundings in shallower water, for which the line was graduated into tens of fathoms, we generally determined by direct measurement, whether taken as independent operations or as a means to test the accuracy of the time-intervals registered when heaving in the lead.

Sounding with the Baillie Machine. — As previously stated, this instrument was got ready for use on the after-deck, just abaft the roundhouse. After arranging, in the manner described above, the sounding-line and the accumulator, we shackled the former either to the ring of the Baillie machine or to the upper eye-bolt of the water-bottle, the lower eye-bolt being in the latter case attached to the ring of the tube. The line was now hauled taut and passed round the drums of the donkey-engine. Then, having deadened the ship's way, we hoisted, by means of the donkey-engine, the whole of the gear over the railing, between the roundhouse and the main shrouds (Fig. 14), and lowered it into the water, to prevent the machine from oscillating and from bumping against the side of the vessel. The deep-sea thermometers were next made fast to the line, 1 or 2 fathoms above the water-bottle or the weight, after which we rapidly veered 200 or 300 fathoms

fast paa Rullen agterud, hvor 2 Mænd stode færdige til at bremse. Derpaa kommanderedes „Lad gaa"! og Lodningen udførtes som ovenfor for Ror-Loddet beskrevet.

Udfiringen af Baillie-Maskinen til 200 eller 300 Favnes Dyb, før man lader gaa, er nødvendig paa Grund af den store Vægt, Lodlinen har at bære, og som vilde gjøre det umuligt med de havende Bremsemidler at kunne regulere Linens Bevægelse. De 200 til 300 Favne Lodline, der ved Operationens Begyndelse allerede er i Vandet, giver saamegen Friktion, at det er Bremserne muligt, om end med Anstrængelse, at holde Rullens og Linens Bevægelse under Kontrol.

Ved Lodning paa større Dyb er det ikke saa let at iagttage det Øjeblik, da Loddet naar Bund, som ved mindre Dybder. Linen lægger sig ikke ned i Dækket, men vedbliver at løbe fra Rullen, efterat Loddet er i Bund, med en Hastighed, der ofte kun er lidet mindre end under Loddets Synken. Ved med udelt Opmærksomhed at følge Linens Fart, navnlig dens Bevægelse gjennem Loddeblokken under Accumulatoren, har man imidlertid et næsten altid sikkert Middel til at observere Øjeblikket, naar Loddet slaar i Bund; man ser da nemlig Blokskivens Rotationshastighed pludselig formindsket. En første Kontrol har man strax deri, at Slakken af Lodlinen nu kan hales ind med Haandmagt, medens det, saalænge Loddet løber, i Regelen vil vise sig ugjørligt ved Haandmagt at standse Bevægelsen. Den sædvanlige Kontrol med Notering af Klokkeslet for hvert Hundredefavnsmærke, som gaar i Vandet, anvendtes jevnlig. Den sidste Kontrol havdes endelig deri, at Accumulatoren i det Øjeblik, Lodrøret (og Vandhenteren) løftedes af Bunden, tydelig strakte sig ud. Fra dette Øjeblik begyndte man, som ovenfor beskrevet, at maale Favnetallet over sidst udløbne Mærke. Naar Øjeblikket, da Loddet slog i Bund, var utvivlsomt at iagttage paa den udløbende Line, viste Methoden med Tidsintervaller for hver 100 udløbne Favne sig ulige paalideligere ved Baillie-Maskinen end ved Rorloddet.

Exempel.

No. 354.		Dato 1878 August 11.	
		Bredde	78° 1′ N.
Klokkeslet	4^h 40^m p. m.	Længde	6° 54′ E. Greew.
Vind	N.	Lufttemperatur	3°,0
Styrke	3	Overflade do.	4°,5
Vejr	Skyet	Dybde	1343 e. Fv.
Sø	3	Bund	Biloculin - Ler
Vægt	315 Pd.	Karakter	Meget godt.

of line with the donkey-engine. The engine was now stopped, the fore part of the line secured with a stopper to an eye-bolt on the deck of the roundhouse, and the after part removed from the drums and tightly wound on the reel aft, where a couple of men stood ready to commence braking. The word being now given to let go, the operation was carried out in the manner described above for sounding with the tube-lead.

Veering the apparatus 200 or 300 fathoms preparatory to letting go, was indispensible with the Baillie machine, owing to the great strain upon the sounding-line, the motion of which would otherwise have been impossible to regulate with the means of braking at our disposal. The friction of the 200 or 300 fathoms of line in the water at the beginning of the operation, enable the brakesmen, though with some little exertion, to command the revolutions of the reel and the motion of the line.

When sounding in greater depths, it is by no means so easy as in water comparatively shallow to tell the exact moment at which the lead touches the bottom. The line will not drop flat on the deck, but go on running off the reel, even after the lead has reached the bottom, and with a velocity but very little inferior to that it had during the descent of the lead. Meanwhile, by closely noting the speed of the line, in particular where it passes through the sounding-block below the accumulator, we have, in the great majority of cases, a sure means of accurately determining the moment when the lead strikes the bottom, the rotation of the sheaf of the block becoming instantly slower. Moreover, the slack part of the line can then be readily brought in by hand, whereas so long as the lead is sinking, it will, as a rule, be found impossible to check its motion by physical strength alone. The usual mode of measurement, by noting down the exact time at which each of the 300 fathom slips entered the water, was frequently adopted. As a final resort, we had the test afforded by the visible extension of the accumulator the instant the sounding-tube and the water-bottle were lifted from the bottom. We then, as stated above, immediately began to measure off the number of fathoms run out after the last slip had entered the water. Provided the arrest of the weight at the bottom could be accurately determined by observing the velocity of the line, the method of measuring by time-intervals, for every 100 fathoms run out, was found to be far more trustworthy with the Baillie machine than with the tube-lead.

Extract from the Sounding-journal.

No. 354.		Date 1878 August 11th.	
		Lat.	78° 1′ N.
Time	4 40 p. m.	Long.	6° 54′ E.
Wind	N.	Temp. of Air	3°. 0.
Force	3	Do. of Sea	4°. 5.
Weather	Cloudy	Depth	1343 Fath.
Sea	3	Bottom	Biloculina Clay.
Weight	315 pounds	Character	Very good.

Favne.	Tid.		Interval.		2den Diff.
	M.	S.	M.	S.	S.
200	16	32			
			0	55	
300	17	27			10
			1	5	
400	18	32			3
			1	8	
500	19	40			9
			1	17	
600	20	57			2
			1	19	
700	22	16			3
			1	22	
800	23	38			19
			1	41	
900	25	19			—5
			1	36	
1000	26	55			2
			1	38	
1100	28	33			1
			1	39	
1200	30	12			4
			1	43	
1300	31	55			
			0	49	
Bund	32	44			

Med det beregnede Interval $1^m\,47^s$ for Længden 1300 til 1400 Favne findes for det observerede Interval af 49^s en Længde af 46 Favne, eller den udledede Dybde 1346 Favne. Ved den nøjere Eftermaaling fandtes 1343 Favne. Paa 78° 2′ N, 6° 44′ E fandt den Svenske Expedition med „Sofia" den 14de August 1868 en Dybde af 1350 Favne. „Sofias" paaværende Plads var omtrent 2 Kvartmil W for „Vöringens", og da Bunden fra Spitsbergen af her skraanede nedad mod Vest er Overensstemmelsen mellem begge Expeditioners Lodninger efter al Sandsynlighed endnu større, end de ovennævnte Tal udtrykker.

Lodlinens Ophaling. Efterat Loddet var kommet i Bund, gaves de medsendte Dybthermometre Tid til at antage det omgivende Vands Temperatur, og derpaa lagdes Lodlinen om Tapperne paa Indhivningsmaskinen. Dens Visning sees af de prikkede Linier i Fig. 14. Fra Fodblokken gik Linen først til agterste Spiltap, derfra frem og tilbage gjennem begge Tappers Furer og endelig paa Rullen. Ophalingen begyndte, og under denne rulledes Lodlinen strax op paa Rullen, saaat den altid var klar til næste Lodskud. Maalingen af Dybden under Ophalingen er ovenfor beskrevet. Indhivningen gik jevnt, og Maskinen bragte 100 Favne Line hjem i Løbet af 3 Minutter.

Naar Loddet nærmede sig Vandskorpen, skede Indhivningen langsommere. Thermometerne toges af Linen, under fornøden Stands i Indhivningen, eftersom de kom over Rækken paa Loddebroen, og tilsidst toges Vandhenter og Lod ind paa denne, hvor de hexedes af. Vandhenteren endevendtes og tømtes af Chemikeren. Bundprøven undersøgtes først, som den laa i Lod-Røret og dens Art noteredes i Loddejournalen. Derpaa toges den ud af Røret og bragtes paa Flasker eller Glas, som forsynedes med Stationens Nummer paa Etiketten. I 1876 brugtes Selterswand-Flasker med Korkeprop, i 1877 og 1878 cylindriske Glas, ca. 10^{cm} høje og brede, der lukkedes med Pergament-

Fathoms.	Time.		Interval.		2nd Diff.
	m.	s.	m.	s.	s.
200	16	32			
			0	55	
300	17	27			10
			1	5	
400	18	32			3
			1	8	
500	19	40			9
			1	17	
600	20	57			2
			1	19	
700	22	16			3
			1	22	
800	23	38			19
			1	41	
900	25	19			—5
			1	36	
1000	26	55			2
			1	38	
1100	28	33			1
			1	39	
1200	30	12			4
			1	43	
1300	31	55			
			0	49	
Bottom	32	44			

The interval computed for 1300 to 1400 fathoms being 1m. 47s., the interval last observed, 49s., will correspond to a length of 46 fathoms, which, added to 1300, gives a depth of 1346 fathoms. By actual measurement, as described above, we got 1343 fathoms. The Swedish Expedition with the "Sophia," sounding on the 14th of August, 1868, in lat. 78° 2′ N., long 6° 44′ E., registered a depth of 1350 fathoms. The position of the "Sofia" was about two miles to the west of that of the "Vöringen;" and as the sea-bed shelves from the shores of Spitzbergen in a westerly direction past this locality, the agreement shown by the soundings of the two Expeditions is probably even greater than expressed by the above figures.

Heaving in the Line. — The lead having reached the bottom, sufficient time was allowed for the deep-sea thermometers to assume the temperature of the surrounding water, after which the sounding-line was passed round the drums of the donkey-engine, as shown by the dotted lines in Fig. 14. From the leading-block, the line was first led to the after drum, then passed backwards and forwards along the grooves of both drums, and finally on to the reel. Thereupon the heaving in commenced, the line, as it came up, being wound on the reel, ready for the next sounding. Our mode of determining the depth when heaving in the lead has been already described. The line was brought in at the uniform rate of 100 fathoms in 3 minutes.

On the lead nearing the surface of the water, the speed of the donkey-engine was reduced. The needful stoppages, too, were made to detach the thermometers as they came over the rail of the sounding-bridge; and finally, the water-bottle and the lead were taken in here and unshackled. The water-bottle was immediately inverted and emptied of its contents, whereas the sample of the bottom was first inspected *in situ*, and its nature registered in the sounding-journal, previous to being taken out of the tube, from which it was transferred to bottles or jars labelled with the number of the observing-station. On the first cruise, in 1876, we used corked soda-water bottles, but in

papir. Bundprøverne overleveredes derpaa til Kemikernes Varetægt.

Loddernes Udløbshastigheder. Efter de i Loddejournalen indeholdte Data gives her nogle Resultater af Studier over Loddernes Bevægelse under Lodningen.

Rørlod. Som tidligere bemærket, var Lodlinens første 200 Favne inddelt med Mærker for hver 10 Favne. Paa Station 375 gjordes et Forsøg til Bestemmelse af Linens eller Loddets Udløbshastigheder under de første 200 Favnes Udløb, idet Tidsøjeblikkene for hvert 10-Favne Mærkes Gaaen i Vandet noteredes, under det at Bremsningen paa Rullen søgtes holdt saa normal som muligt. Resultatet af dette Forsøg indeholdes i den følgende Tabel.

Favne.	Tid fra „Lad gaa".		Interval.	Hastighed. Favne pr. Sek.
0	0.m	0s		
10		6	6s	1.67
20		12	6	1.67
30		15	3	3.33
40		19	4	2.50
50		25	6	1.67
60		32	7	1.43
70		37	5	2.00
80		44	7	1.43
90		50	6	1.67
100		57	7	1.43
110	1	4	7	1.43
120	1	11	7	1.43
130	1	19	8	1.25
140	1	27	8	1.25
150	1	34	7	1.43
160	1	42	8	1.25
170	1	51	9	1.11
180	1	59	8	1.25
190	2	7	8	1.25
200	2	16	9	1.11

Man ser af Rubrikken „Hastighed i Favne pr. Sek.", at Hastigheden, hvormed Loddet synker, der er lig Nul i det Øjeblik, man „lader gaa", i Begyndelsen er voxende, men naar sit Maximum allerede ved 25 Favnes Dyb, og derpaa er den gjennemsnitlig aftagende med Dybden, idet Linens Friktion i Vandet samtidig med at Bremsningen er lettere at regulere, bevirker en større Modstand mod Bevægelsen.

Af Iagttagelser af Udløbstiderne for 100 Favnemærkerne paa en større Række Stationer findes som gjennemsnitlige Værdier de i den følgende Tabel opførte Tal:

1877 and 1878 cylindrical glass jars, about 4 inches high and wide and covered at the top with strong vellum paper. When ready for storing, the samples of the bottom were left in charge of the chemist to the Expedition.

Velocity of the Lead. — In this Section we give some results obtained by investigating the rate of descent from the data registered in the sounding-journal.

The Tube-lead. — As previously stated, the line was graduated for the first 200 fathoms into lengths of tens of fathoms. At Station 375, we sought to determine the absolute rate of descent down to a depth of 200 fathoms, by registering the exact moment at which each of the ten-fathom slips entered the water, striving the while to keep the braking as uniform as possible. The following Table shows the results of the experiment.

Fathoms.	Time.		Interval.	Velocity. Fath. pr. Sec.
0	0.m	0s		
10		6	6s	1.67
20		12	6	1.67
30		15	3	3.33
40		19	4	2.50
50		25	6	1.67
60		32	7	1.43
70		37	5	2.00
80		44	7	1.43
90		50	6	1.67
100		57	7	1.43
110	1	4	7	1.43
120	1	11	7	1.43
130	1	19	8	1.25
140	1	27	8	1.25
150	1	34	7	1.43
160	1	42	8	1.25
170	1	51	9	1.11
180	1	59	8	1.25
190	2	7	8	1.25
200	2	16	9	1.11

We see from a glance at the column headed "Velocity in fathoms pr. second," that the rate of descent, which at the moment of letting go is nil, tends at first to increase, soon however reaching its maximum, at a depth of 25 fathoms, after which it begins, and as a rule continues, to decrease with the depth, the augmenting friction in the water, along with increased facility of braking, together occasioning greater resistance to the downward motion of lead and line.

The figures in the following Table are deduced from the intervals, timed at a number of Stations, for every hundred-fathom slip that successively entered the water, and represent the average rate of decent.

Favne.	Tid fra „lad gaa".	Interval.	Hastighed Favne pr. Sek.
0	0ᵐ 0ˢ		
100	55	0ᵐ 55ˢ	1.82
200	2 12	1 17	1.29
300	3 42	1 30	1.11
400	5 18	1 36	1.05
500	7 6	1 48	0.92
600	9 7	2 1	0.83
700	11 15	2 8	0.78
800	13 29	2 14	0.75
(900)	(16 10)	(2 41)	(0.62)

For Intervallet 800—900 Favne haves kun en Observation.

De her fundne Hastigheder slutter sig meget godt til de ovenfor fundne, efter hvilke Gjennemsnitshastigheden mellem 0 og 100 Favne er 1.82 og mellem 100 og 200 Favne 1.28. Man ser endvidere, at Loddets Hastighed er stadig aftagende med Dybden. Udjevner man paa grafisk Vej Hastighederne i den første Tabel og slutter denne Række til den anden, der beror paa flere Iagttagelser, saaledes at Tidsintervallerne i den sidste beholdes, saa faar man et Billede af Rørloddets Bevægelse saaledes som Kurverne R i Fig. 15 og 16 viser. Fig. 15 viser de til de forskjellide Tider udløbne Længder af Lodlinen, og Fig. 16

Fathoms.	Time.	Interval.	Velocity Fath. p. Sec.
0	0ᵐ 0ˢ		
100	55	0ᵐ 55ˢ	1.82
200	2 12	1 17	1.29
300	3 42	1 30	1.11
400	5 18	1 36	1.05
500	7 6	1 48	0.92
600	9 7	2 1	0.83
700	11 15	2 8	0.78
800	13 29	2 14	0.75
(900)	(16 10)	(2 41)	(0.62)

For the 800—900-fathom interval we have only one observation.

The velocities thus determined agree pretty well with those previously found, which average 1.88 between 0 and 100 fathoms and 1.28 between 100 and 200 fathoms. Moreover, the rate of descent decreases steadily with the depth. Now, if we equalize, in a diagrammatic form, the velocities given in the first Table, and adjust that series to the second, retaining the time-intervals of the latter, as based on a greater number of observations, we shall have figured before us the descent of the tube-lead, as represented by the curves R, R, in Figs. 15 and 16. Fig 15 shows the lengths of sounding-line run out during succes-

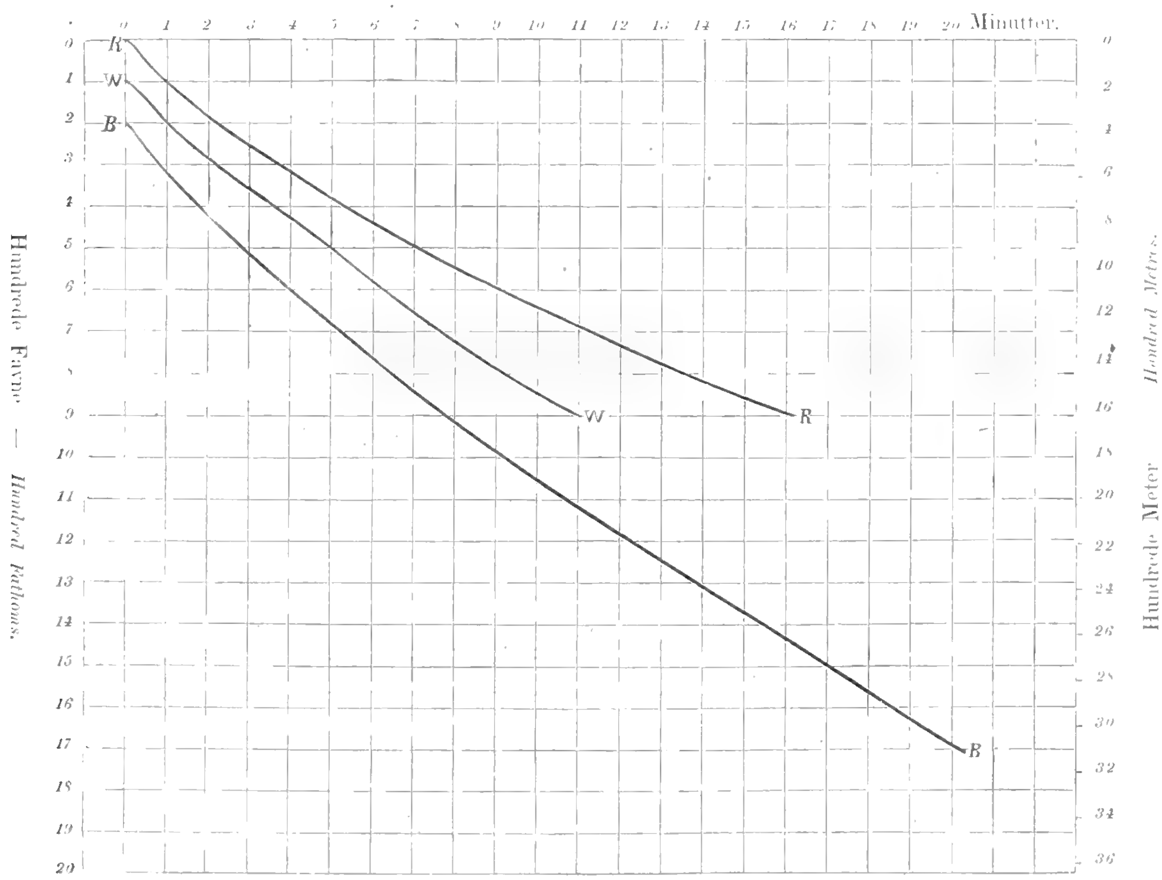


Fig. 15.

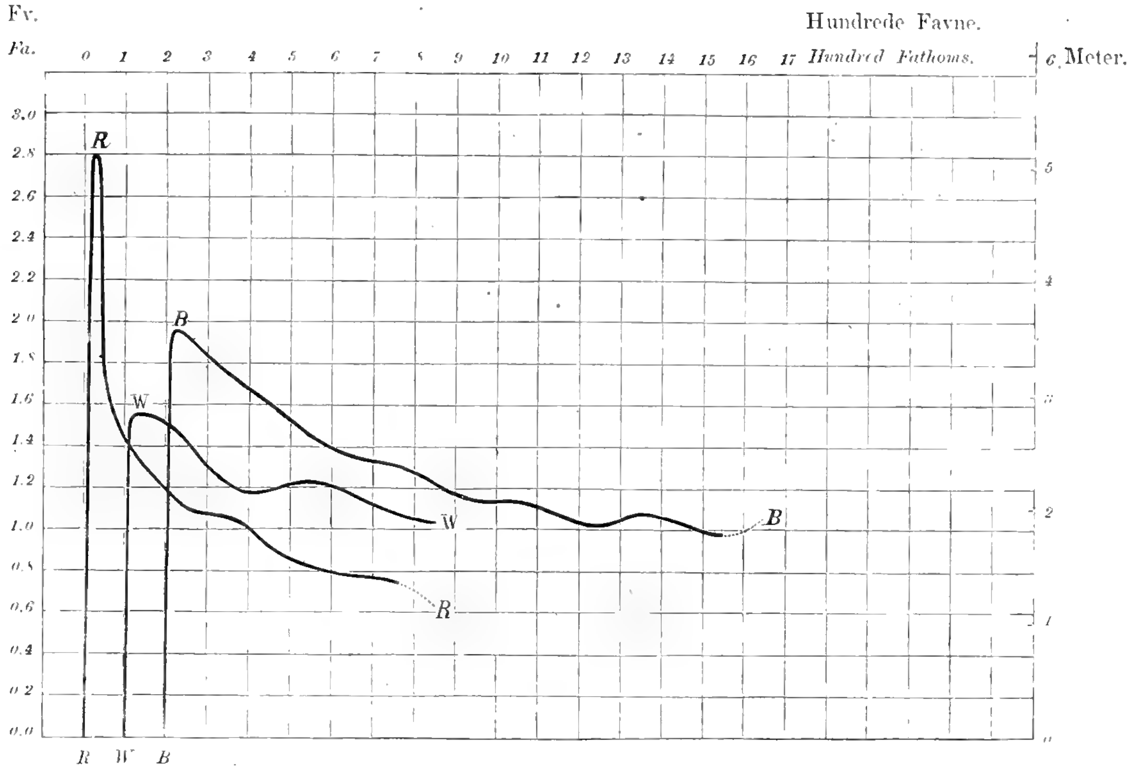


Fig. 16.

Hastighederne, udtrykt i Favne pr. Sekund, i de forskjellige Dybder. I den første Del af Fig. 16, fra 0 til 200 Favne, er Hastighederne afsat for hver 10de Favn, regnet fra 5 Favne af, i den sidste Del er Hastighederne afsat for hver 100 Favn, regnet fra 250 Favne af.

Rørlod med Willes Vandhenter. Nedenstaaende Tabel viser Synkningen af Rørloddet med Willes Vandhenter, fra 100 Favnes Dyb af, til hvilken Dybde det blev udfiret fra Indhivningsmaskinen, før man „lod gaa". Iagttagelserne hidrører for Størstedelen fra 1876.

Favne.	Tid fra „lad gaa".		Interval.		Hastighed. Fv. pr. Sek.
100	0^m	0^s			
200	1	4	1^m	4^s	1.56
300	2	14	1	10	1.43
400	3	36	1	22	1.22
500	5	0	1	24	1.19
600	6	22	1	22	1.22
700	7	46	1	24	1.19
800	9	18	1	32	1.09
900	10	55	1	37	1.03

Fra det Øjeblik, da man „lader gaa", i hvilket Hastigheden er Nul, voxer den raskt til et Maximum, og er siden gjennemsnitlig aftagende med Dybden. Tabellens Resultater er fremstillet grafisk i Figg. 15 og 16 ved Kurverne W. Man ser, at den Hastighed, med hvilken

sive intervals; and Fig. 16 the rate of descent, in fathoms pr. second, at the different depths. In the left part of Fig. 16, from 0 to 200 fathoms, the velocities are given for tens of fathoms: in the right part of the figure, for hundreds, beginning with 250 fathoms.

The Tube-lead with Wille's Water-bottle attached. — The following Table shows the rate of descent of the tube-lead when sent down along with Wille's water-bottle, beginning at 100 fathoms, to which depth the apparatus were sunk with the donkey-engine before being cast off. The observations date chiefly from 1876.

Fathoms.	Time.		Interval.		Velocity Fath. pr. Sec.
100	0^m	0^s			
200	1	4	1^m	4^s	1.56
300	2	14	1	10	1.43
400	3	36	1	22	1.22
500	5	0	1	24	1.19
600	6	22	1	22	1.22
700	7	46	1	24	1.19
800	9	18	1	32	1.09
900	10	55	1	37	1.03

From the moment of casting off, when the velocity is nil, the rate of descent rapidly increases up to a maximum, and then, as a general rule, decreases with the depth. The results set forth in the Table are represented diagrammatically, by the curves W, W in Figs. 15 and 16. It is obvious

Loddet slaar i Bund, er mærkelig større, naar Vandhenteren er paa, end med Rorloddet alene.

Baillie-Maskinen. Den følgende Tabel er Middelresultater af Forsøg med Baillie-Maskinen, med en total Belastning fra 142 til 182 Kilo (285 til 365 Pd.), gjennemsnitlig 171 Kilogram (342 Pd.), efter et større Antal Iagttagelsesrækker.

Favne.	Tid fra "lad gaa."	Interval.	Hastighed Favne pr. Sek.
200	0^m 0^s		
300	0 51	0^m 51^s	1.96
400	1 48	0 57	1.76
500	2 50	1 2	1.60
600	3 59	1 9	1.46
700	5 12	1 13	1.37
800	6 27	1 15	1.33
900	7 48	1 21	1.23
1000	9 15	1 27	1.16
1100	10 43	1 28	1.14
1200	12 16	1 33	1.08
1300	13 53	1 37	1.03
1400	15 27	1 34	1.07
1500	17 5	1 38	1.02
1600	18 46	1 41	0.99
1700	20 20	1 34	1.06

Kurverne B i Figg. 15 og 16 viser Tabellens Resultater.

Sammenligner man Kurverne i Fig. 16, saa ser man strax, hvorledes det tungere Lod slaar i Bund med en større Hastighed end det lettere, og Nødvendigheden af tungere Lod til de dybere Lodskud fremtræder med Styrke. Figuren viser tydelig, hvorledes Rørloddet alene kommer til kort paa Dybder over 1000 Favne, saaledes som Erfaringen har vist.

Et fælles Træk for alle tre Hastighedskurver er deres bølgeformige Løb paa større Dybder. Dette forklares ved Bremsningens Ujevnhed. Bremsningen paa Rullen er paavirket af Søgangen, idet den falder lettere at regulere i roligt Vejr end i uroligt, naar Fartøjet løfter og sænker sig og derunder snart rykker i Linen, snart gaar med dens Bevægelse. Men Ujevnheden i Bremsningen er vistnok ogsaa af fysiologisk Natur. Under den første Del af Loddets Udløb bremser Folkene paa Rullen med friske Kræfter og udelt Opmerksomhed. Figuren viser i den tilsvarende Del af Hastighedskurverne den største Regelmæssighed. Saa bliver Bremserne trætte og mindre agtpaagivende. Lodlinen begynder at slænge op og ned og til Siderne paa Vejen fra Rullen til Fodblokken. Et „brems ordentligt" fra den kommanderende Officiers Mund bringer atter Regelmæssighed i Bevægelsen, men denne afløses igjen af Virkningen af Træthed under det fortsatte anstrængende Arbejde og saa fremdeles. Disse Perioder i Hastigheden

that the velocity of the lead when it strikes the bottom is perceptibly greater with the water-bottle attached than without.

The Baillie Machine. — The following Table gives the mean results computed from an extensive series of soundings with the Baillie machine, the total sinking-weight, which varied from 285 to 365 pounds, having averaged 342 pounds:

Fathoms.	Time.	Interval.	Velocity Fath. pr. Sec.
200	0^m 0^s		
300	0 51	0^m 51^s	1.96
400	1 48	57	1.76
500	2 50	1 2	1.60
600	3 59	1 9	1.46
700	5 12	1 13	1.37
800	6 27	1 15	1.33
900	7 48	1 21	1.23
1000	9 15	1 27	1.16
1100	10 43	1 28	1.14
1200	12 16	1 33	1.08
1300	13 53	1 37	1.03
1400	15 27	1 34	1.07
1500	17 5	1 38	1.02
1600	18 46	1 41	0.99
1700	20 20	1 34	1.06

The curves B, B in Figs. 15 and 16, are constructed from the results set forth in this Table.

A glance at the curves in Fig. 16, shows that the heavier the lead the greater will be its velocity on reaching the bottom; and hence the need of increasing the sinking-weight for deeper soundings. The diagram clearly discloses the untrustworthiness of the tube-lead as a sounding-instrument for depths of more than 1000 fathoms, thus confirming the result of experience.

A common feature distinguishing the three curves of velocity is their sinuous course in great depths. This must be ascribed to want of uniformity in braking. The said operation is disadvantageously affected in a seaway, the revolutions of the reel being easier to regulate in calm than in rough weather, when the vessel heaves and sinks, now dragging after her the line, and now following its motion. Meanwhile, the cause of irregular braking is in part, no doubt, physiological. The men, who come to their work fresh, brake at first with skill and undivided attention. This is evident from the diagram, which exhibits greatest regularity of form in the corresponding portion of the curve of velocity. After a time, the brakesmen get tired, and in consequence less attentive. The sounding-line is jerked up and down and sideways on its passage from the reel to the leading-block. By an encouraging word, the officer in charge can, indeed, for a time, restore regularity to the braking; but soon the effects of lassitude, brought

falder nu vistnok ikke i ethvert Tilfælde paa samme Tid eller rettere samme Dybde, men Kurverne antyder, saaledes som ogsaa de grafisk opsatte Kurver for de enkelte Lodninger viser, at der er en vis Regelmæssighed i Ujevnhederne, saaledes at disse falder nogenlunde omkring samme Dybdetal ved de forskjellige Tilfælder.

Den Tid, som behøves til at tage et Lodskud er væsentlig afhængig af Lodskuddets Dybde. Efter Skibsjournalen, i hvilken anførtes Klokkeslettene for Lodningens Begyndelse, naar Fartøjet stoppede, og for dens Afslutning, naar der atter sattes i Gang igjen, eller naar en anden Operation, som Temperaturrække eller Skrabning, begyndte, findes ved en statistisk Beregning, at i Gjennemsnit krævede et Lodskud paa

100 Favne	20 Minutter.
500 —	40 —
1000 —	1 Time.
1500 —	1 Time 30 Minutter.
2000 —	henimod 2 Timer.

eller i Almindelighed

$$\text{Tiden for et Lodskud} = 20^m + 5^m \times \frac{(\text{Dybden i Fv.} - 100)}{100}.$$

Denne Tid forbruges omtrent saaledes som følgende Skema viser.

Dybde i Favne	100	500	1000	1500	2000
Vægt af Lod i Pund	112	112	285	350	365
	Minutter.				
Stopning af Fartøjet, Forbered. til Lodning	10^m	10^m	10^m	10^m	10^m
Udfiring til 300 Favne à 3 Minutter pr. 100 Favne	0	0	9	9	9
Paasætning af Stopper, Linen taget fra Indhivningsmaskinen til Rullen	0	0	3	3	3
Udløbstid til Bunds efter Fig. 15	1	7	9	17	25
Thermometrenes Accomodation, Lodlinens Skiftning fra Rul til Spil	8	5	5	5	5
Indhivning à 3 Min. pr. 100 Favne	3	15	30	45	60
Ialt	22	37	66	89	112
Ovenst. Formel giver	20	40	65	90	115
Forskjel	+2	—3	+1	—1	—3

on by the unintermitting exertion, are again apparent, to be again counteracted for a still shorter interval, and so on *de novo*, to the end of the operation. True, these periodical deviations in velocity do not occur in every case precisely at the same time, or rather at the same depth, but the curves here given, as also those diagrammatically constructed for each individual sounding, indicate a certain regularity in the inequalities, and a tendency to occur at about the same depth in all cases.

The Time required for Sounding depends mainly on the depth. From data in the ship's log-book, comprising the time at which each sounding commenced, — viz. when the vessel was stopped, — and that of its termination, when she again went ahead, — or the time at which some other operation, such as dredging or taking a serial temperature, was begun, we found, by direct computation, the time each sounding occupied to average as follows: —

100 Fathoms	20 Minutes.
500 —	40 —
1000 —	1 Hour.
1500 —	1 Hour 30 Minutes.
2000 —	Nearly 2 Hours.

Hence a sounding occupied $20^m + 5^m \times$ (the depth in fathoms —100): 100; and this interval passed very nearly as set forth in the following tabular statement.

Depth in Fathoms	100	500	1000	1500	2000
Sinking-weight in pounds	112	112	285	350	365
	Minutes.				
Stopping vessel and preparing for sounding	10^m	10^m	10^m	10^m	10^m
Veering 300 fathoms of Line, at 3 min. pr. 100 fathoms	0	0	9	9	9
Putting on stoppers and shifting Line from drum of donkey-engine to the reel	0	0	3	3	3
Time required for reaching bottom, according to Fig. 15	1	7	9	17	25
Time for Accomodation of the Thermometers, and for shifting Line from the reel to drum of donkey-engine	8	5	5	5	5
Heaving in at 3m. pr. 100 fathoms	3	15	30	45	60
Total	22	37	66	89	112
The above formula gives	20	40	65	90	115
Difference	+2	—3	+1	—1	—3

Paa Norhavsexpeditionens trende Undersøgelsesrejser toges nedenstaaende Lodskud. Til at betegne Bundens Beskaffenhed er anvendt følgende Forkortelser:

b — blaa.	blk — sort.	br — brun.			
c — grov.	cl — Ler.	d — mørk.			
f — fin.	g — Singels.	gn — grøn.			
gy — graa.	h — haard.	m — Mudder.			
oz — Slik.	r — Fjeld.	s — Sand.			
sft — blød.	sh — Skjæl.	st — Sten.			
B. cl — Biloculin-Ler.		y — gul.			

On the three exploring cruises of the Norwegian North-Atlantic Expedition, the following soundings were taken. The abbreviations given below, denote the nature of the bottom.

b — blue.	blk — black.	br — brown.
c — coarse.	cl — clay.	d — dark.
f — fine.	g — gravel.	gn — green.
gy — grey.	h — hard.	m — mud.
oz — ooze.	r — rock.	s — sand.
sft — soft.	sh — shells.	st — stones.
B. cl — Biloculina clay.		y — yellow.

Stat. No.	Nordlig Bredde. (North Latitude.)	Længde fra Greenwich. (Longitude from Greenwich.)	Dybde. (Depth.) N. Favne. (Norw. Fths.)	E. Favne. (Fathoms.)	Meter. (Metres.)	Bund. (Bottom.)
2	61° 10.'	6° 32.' E	653	672	1229	s & cl
3	61 5	5 15 E	600	618	1130	do.
4	61 5	5 1 E	550	566	1035	s. cl. g
5	61 6	5 12 E	490	504	922	s. cl
6	61 6	5 9 E	205	211	386	r
7	61 6	5 11 E	200	206	377	r
9	61 30	3 37 E	200	206	377	cl
10	61 41	3 19 E	214	220	402	oz. cl
11	61 47	3 9 E	225	232	424	cl
12	61 53	3 0 E	217	223	408	cl
13	61 58	2 54 E	221	228	417	cl
14	62 4	2 45 E	220	226	413	cl
15	62 10	2 36 E	215	221	404	cl
16	62 24	2 17 E	215	221	404	r
17	62 33	2 4 E	280	288	527	r
18	62 44	1 48 E	400	412	753	cl
19	62 23	2 50 E	220	226	413	cl. s
20	62 16	3 8 E	213	219	400	cl
21	62 14	3 28 E	183	188	344	cl. s
22	62 13	3 41 E	125	129	236	cl. s
24	63 10	5 58 E	87	90	165	s. cl
26	63 10	5 16 E	230	237	433	s. cl
	63 7	5 17 E	87	90	165	r
27	63 6	5 18 E	85	87	159	r
28	63 10	5 11 E	385	396	724	s. cl
29	63 10	5 7 E	385	396	724	s. cl
30	63 10	5 4 E	390	401	733	s. cl
31	63 10	5 0 E	405	417	763	s. cl
32	63 10	4 51 E	418	430	786	s. cl
33	63 5	3 0 E	510	525	960	cl
34	63 5	0 53 E	570	587	1073	oz
35	63 2	1 12 W	1000?	—	—	cl
	63 7	1 26 W	1050	1081	1977	cl
36	62 15	4 34 W	144	148	271	st
37	62 28	2 29 W	670	690	1262	s. cl
38	63 1	3 58 W	198	204	373	r
40	63 22	5 29 W	1180	1215	2222	s. cl
41	63 37	7 10 W	677	697	1275	cl

Stat. No.	Nordlig Bredde. (North Latitude.)	Længde fra Greenwich. (Longitude from Greenwich.)	Dybde. (Depth.) N. Favne. (Norw. Fths.)	E. Favne. (Fathoms.)	Meter. (Metres.)	Bund. (Bottom.)
42	63° 2.'	10° 17.' W	256	264	483	r
43	63 11	13 32 W	514	529	967	s
44	63 8	14 0 W	820	844	1543	r
45	63 28	12 58 W	370	381	697	r. cl
46	63 51	12 5 W	250	257	470	s. cl
47	64 13	11 14 W	185	190	347	r
48	64 36	10 22 W	290	299	547	s. oz
49	65 0	9 25 W	425	437	799	s. cl
50	65 26	8 24 W	555	571	1044	cl
51	65 53	7 18 W	1130	1163	2127	B. cl
52	65 47	3 7 W	1808	1861	3403	B. cl
53	65 13	0 33 E	1495	1539	2814	B. cl
54	64 47	4 24 E	584	601	1099	B. cl
55	64 38	10 22 E	90	93	170	r
56	64 39	10 11 E	173	178	326	s. cl
57	64 39	9 59 E	156	161	294	cl
58	64 39	9 49 E	215	221	404	s. cl
59	64 39	9 38 E	162	167	305	s. cl
60	64 40	9 30 E	115	118	216	h. cl
61	64 40	9 19 E	115	118	216	h. cl
62	64 41	9 10 E	105	108	198	h. cl
63	64 41	9 0 E	90	93	170	r
64	64 42	8 50 E	56	58	106	r
65	64 42	8 39 E	60	62	113	r
66	64 43	8 30 E	85	88	161	s. cl
67	64 44	8 19 E	116	119	218	s. cl
68	64 44	8 9 E	128	132	241	cl
69	64 45	8 2 E	124	128	234	cl. s
70	64 45	7 53 E	126	130	238	cl. s
71	64 45	7 46 E	128	132	241	s. cl
72	64 46	7 37 E	133	137	251	s. cl
73	64 46	7 28 E	129	133	243	s. cl
74	64 47	7 20 E	128	132	241	s. cl
75	64 47	7 13 E	141	145	265	s. cl
76	64 47	7 4 E	145	149	272	s. cl
77	64 48	6 54 E	145	149	272	s. cl
78	64 48	6 45 E	151	155	283	s. cl
79	64 48	6 36 E	151	155	283	s. cl

Stat. No.	Nordlig Bredde. (North Latitude.)	Længde fra Greenwich. (Longitude from Greenwich).	Dybde. (Depth.) N. Favne. (Norw. Fths.)	E. Favne. (Fathoms.)	Meter. (Metres.)	Bund. (Bottom.)	Stat. No.	Nordlig Bredde. (North Latitude.)	Længde fra Greenwich. (Longitude from Greenwich.)	Dybde. (Depth.) N. Favne. (Norw. Fths.)	E. Favne. (Fathoms.)	Meter. (Metres.)	Bund. (Bottom.)
80	64° 48.'	6° 26.' E	140	144	263	cl	138	67° 18.'	9° 9.' E	179	184	336	c. s. cl
81	64 49	6 17 E	151	155	283	cl	139	67 14	9 25 E	170	175	320	cl. s. st
82	64 49	6 7 E	170	175	320		140	67 10	9 42 E	191	197	360	cl. s
83	64 49	5 58 E	180	185	338	cl	141	67 6	9 59 E	186	192	351	cl. s
84	64 49	5 49 E	215	221	404	cl	142	67 2	10 17 E	173	178	326	cl. s
85	64 50	5 39 E	294	303	554	br. cl	143	66 58	10 33 E	183	189	346	cl.
86	64 50	5 30 E	370	381	697	cl	144	66 53	10 50 E	178	183	335	cl. s st
87	64 2	5 35 E	484	498	911	cl	145	66 49	11 7 E	192	198	362	cl. s
88	64 1	5 53 E	345	355	649	cl	146	66 45	11 22 E	175	180	329	cl. s. st
89	64 1	6 8 E	185	190	347	r	147	66 49	12 8 E	138	142	260	sft. cl. s
90	64 1	6 21 E	199	205	375	s. cl	148	67 27	13 25 E	146	150	274	cl
91	64 0	6 32 E	185	190	347	gy. cl	150	67 11	13 21 E	183	189	346	cl
92	64 0	6 42 E	173	178	326	cl	151	67 15	13 4 E	123	127	232	r
93	62 41	7 8 E	153	158	289	sft. cl	152	67 18	12 46 E	121	125	229	sft. cl
94	59 8	4 38 E	142	145	265	cl	153	67 22	12 29 E	118	122	223	s. cl
95	60 42	4 14 E	170	175	320	cl	154	67 26	12 14 E	76	78	143	r
96	66 8	3 0 E	782	805	1472	B. cl	155	67 35	11 46 E	70	72	132	r
97	66 2	4 21 E	663.5	683	1249	cl	156	67 40	11 26 E	87	90	165	r
98	65 56	5 21 E	377	388	710	cl	157	67 45	11 7 E	103	106	194	r
99	65 51	6 25 E	207	213	390	cl	158	67 49	10 49 E	99	102	187	d. cl. s
100	65 43	7 29 E	188	194	355	cl	159	67 54	10 30 E	115	118	216	s. g. sh
101	65 36	8 32 E	216	223	408	cl	160	67 58	10 11 E	272	280	512	r. cl
102	65 32	9 10 E	205	211	386	cl	161	68 3	9 53 E	575	592	1083	f. s. cl
103	65 30	9 37 E	187	193	353	cl	162	68 23	10 20 E	772	795	1454	br. cl
104	65 28	9 56 E	157	162	296	cl	163	68 22	10 30 E	670	690	1262	br. cl
105	65 26	10 13 E	141	145	265	s. cl	164	68 21	10 40 E	443	457	836	gy. cl s
106	65 24	10 33 E	172	177	324	cl	165	68 46	10 51 E	1428	1470	2688	B. cl
107	65 21	10 44 E	167	172	315	cl. g	166	68 40	11 40 E	394	406	742	cl
108	66 6	11 1 E	123	127	232	s. cl	167	68 37	12 2 E	77	79	144	r
109	66 10	10 41 E	175	180	329	s. cl	168	68 39	11 51 E	431	444	812	br. cl
110	66 12	10 30 E	154	159	291	cl	169	68 36	12 53 E	70	72	132	r
111	66 15	10 21 E	152	157	287	s. cl	170	68 32	13 18 E	65	67	123	r
112	66 16	10 10 E	134	138	252	cl. s	171	69 18	14 29 E	624	642	1174	br. cl
113	66 18	10 0 E	119	123	225	cl. s	172	69 12	14 47 E	79	81	148	r
114	66 18	9 51 E	116	120	219	cl. s	173	69 14	14 43 E	233	240	439	r
115	66 20	9 41 E	128	132	241	cl. s	174	69 16	14 38 E	327	337	616	cl. st
116	66 21	9 30 E	117	121	221	cl. st	175	69 17	14 35 E	403	415	759	cl. g
117	66 23	9 20 E	137	141	258	cl. s	176	69 18	14 33 E	521	536	980	cl
118	66 26	8 59 E	137	141	258	cl. s.	177	69 25	13 49 E	1402	1443	2639	br. cl
119	66 28	8 40 E	163	168	307	cl	178	69 29	12 26 E	1533	1578	2886	B. cl
120	66 30	8 20 E	184	190	347	cl	179	69 32	11 10 E	1561	1607	2939	B. cl
121	66 33	7 59 E	186	192	351	cl. sh	180	69 39	9 55 E	1549	1594	2915	B. cl
122	66 36	7 40 E	195	201	368	cl. s	181	69 45	8 43 E	1549	1595	2917	B. cl
123	66 39	7 19 E	239	246	450	cl. st	182	69 51	7 30 E	1636	1684	3080	B. cl
124	66 41	6 59 E	340	350	640	cl	183	69 59	6 15 E	1661	1710	3127	B. cl
125	67 52	5 12 E	680	700	1280	cl	184	70 4	9 50 E	1503	1547	2829	B. cl
126	67 49	5 33 E	709	730	1335	br. cl	185	70 3	13 37 E	1442	1485	2716	B. cl
127	67 47	5 54 E	694	715	1308	cl	186	69 56	14 18 E	1378	1418	2593	B. cl. st
128	67 43	6 21 E	668	688	1258	cl	187	69 51	14 41 E	1297	1335	2441	br. cl
129	67 40	6 42 E	689	709	1296	br. cl	188	69 43	15 29 E	1151	1185	2167	br. cl
130	67 38	7 3 E	669	689	1260	cl	189	69 41	15 42 E	835	860	1573	br cl.
131	67 35	7 26 E	772	795	1454	sft. br. cl	190	69 41	15 51 E	845	870	1591	br. cl. s
132	67 33	7 48 E	927	954	1745	br. cl	191	69 44	16 26 E	242	249	455	sh. st. s
133	67 30	8 10 E	862	890	1628	br. cl	192	69 46	16 15 E	630	649	1187	s. cl
134	67 29	8 20 E	853	878	1606	cl	193	69 44	16 54 E	45	46	84	r
135	67 27	8 31 E	835	860	1573	cl	194	69 43	17 16 E	28	29	53	r
136	67 25	8 47 E	593	610	1116	h. cl. g	195	70 55	18 38 E	104	107	196	st. cl
137	67 24	8 58 E	438	452	827	h. cl	196	71 2	18 3 E	118	122	223	cl. s

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197	71° 7.'	17° 28.' E	134	138	252	r
198	71 13	16 52 E	219	226	413	r
199	71 18	16 17 E	510	525	960	r
200	71 25	15 41 E	602	620	1134	br. cl
201	71 31	15 28 E	628	647	1183	br. cl. s
202	71 31	14 40 E	780	803	1468	cl
203	71 31	13 54 E	875	901	1648	br. cl. st
204	70 57	13 34 E	1230	1266	2315	B. cl
205	70 51	13 3 E	1250	1287	2354	B. cl.
206	70 45	14 36 E	1212	1248	2282	B. cl
207	70 33	15 50 E	1079	1111	2032	B. cl
208	70 21	16 57 E	656	675	1234	br. cl. st
209	70 19	17 9 E	122	126	230	r
210	70 17	17 20 E	133	137	251	r
211	70 15	17 31 E	125	129	236	s. cl
212	70 12	17 41 E	138	142	260	s. cl
213	70 23	2 30 E	1710	1760	3219	B. cl
214	70 39	0 0	1700	1750	3200	B. cl
215	70 53	2 0 W	1617	1665	3045	B. cl
216	70 58	3 40 W	1196	1231	2251	s. cl
217	71 0	5 9 W	805	829	1516	B. cl
218	71 1	6 0 W	940	968	1770	B. cl
219	71 2	6 51 W	773	796	1456	B. cl
220	71 2	7 26 W	1238?	1275?	2332?	?
221	71 2	7 35 W	1030	1060	1938	r
222	71 2	7 46 W	635	654	1196	r
223	70 54	8 24 W	68	70	128	blk. cl. s
224	70 51	8 20 W	92	95	174	blk. s
225	70 58	8 4 W	189	195	357	blk. cl. s
226	70 59	7 51 W	330	340	622	blk. cl. s
227	71 13	7 33 W	1010	1040	1902	br. cl
228	71 12	8 9 W	906	933	1706	r
229	71 12	8 55 W	711	732	1339	br. cl
230	71 16	9 10 W	830	854	1562	br. cl
231	71 21	9 23 W	1002	1032	1887	br. cl
232	71 10	8 48 W	758	780	1426	br. cl
233	71 8	8 46 W	563	580	1061	br. cl
234	71 6	8 38 W	251	259	474	blk. cl. s
235	70 59	8 55 W	95	98	179	r
236	70 58	9 2 W	151	156	285	blk. s. cl
237	70 41	10 10 W	255	263	481	br. s. cl
238	70 13	10 54 W	821	845	1545	B. cl
239	69 35	11 13 W	1020	1050	1920	B. cl
240	69 2	11 26 W	975	1004	1836	B. cl
241	68 41	10 54 W	1087	1119	2046	B. cl
242	68 36	8 40 W	1003	1033	1889	B. cl
243	68 32	6 26 W	1345	1385	2533	B. cl
244	68 28	4 17 W	1895	1951	3568	B. cl
245	68 21	2 5 W	1948	2005	3667	B. cl
246	68 14	0 6 E	1546	1592	2911	B. cl
247	68 5	2 24 E	1088	1120	2048	y. cl
248	67 56	4 11 E	756	778	1423	B. cl
249	68 12	6 35 E	1033	1063	1944	B. cl
250	68 10	9 20 E		1150?		y. cl. g
251	68 6	9 44 E	616	634	1159	br. cl
253	I Skjærstadfjorden		255	263	481	gy. cl
254	67° 27.'	13° 25 E	139	143	262	b. cl
255	68 12	15 40 E	331	341	624	b. cl
256	70° 8.'	23° 4.' E	218	225	411	gn. cl
257	70 4	23 2 E	155	160	293	gy. cl
258	70 13	23 3 E	223	230	421	gn. cl
259	70 49	25 59 E	78	80	146	r
260	70 55	26 11 E	123	127	232	cl
261	70 47	28 30 E	123	127	232	cl
262	70 36	32 35 E	144	148	271	cl
263	70 44	34 14 E	117	121	221	cl
264	70 56	35 37 E	84	86	157	sft. cl
265	71 18	34 49 E	102	105	192	h. cl
266	71 27	35 39 E	126	130	238	sft. cl
267	71 42	37 1 E	144	148	271	cl. st
268	71 36	36 18 E	126	130	238	cl. s
269	72 11	36 40 E	134	138	252	gn. cl
270	72 27	35 1 E	132	136	249	br. cl
271	72 38	33 50 E	155	160	293	gn. cl
272	73 11	33 3 E	110	113	207	cl. s
273	73 25	31 30 E	191	197	360	gn. cl
274	73 46	31 16 E	177	182	333	cl
275	74 8	31 12 E	143	147	269	gn. cl
276	74 5	27 39 E	214	220	402	gn. cl
277	74 3	25 43 E	218	225	411	gn. cl
278	74 1	22 27 E	223	230	421	gn. cl
279	74 15	20 48 E	77	79	144	st. sh. cl
280	74 10	18 51 E	34	35	64	r
281	74 3	17 18 E	112	115	210	r
282	73 53	15 36 E	444	457	836	sft. gn. cl
283	73 47	14 21 E	745	767	1403	br. cl
284	73 1	12 58 E	777	800	1463	br. cl
285	73 6	11 56 E	995	1024	1873	br. cl
286	72 57	14 32 E	434	447	817	gy. cl
287	72 52	15 19 E	242	249	455	gy. cl
288	72 46	17 50 E	209	215	393	br. cl
289	72 41	20 18 E	213	219	400	gn. cl
290	72 27	20 51 E	185	191	349	cl. s
291	71 54	21 57 E	188	194	355	gy. cl
292	71 20	22 59 E	210	216	395	gy. cl
293	71 7	21 11 E	92	95	174	s. cl
294	71 35	15 11 E	619	637	1165	sft. br. cl
295	71 59	11 40 E	1078	1110	2030	B. cl
296	72 15	8 9 E	1399	1440	2633	B. cl
297	72 36	5 12 E	1243	1280	2341	B. cl
298	72 52	1 51 E	1457	1500	2743	B. cl
299	73 10	2 14 W	1327	1366	2498	B. cl
301	74 1	1 20 W	1636	1684	3080	B. cl
302	75 16	0 54 W	1928	1985	3630	B. cl
303	75 12	3 2 E	1166	1200	2195	B. cl
304	75 3	4 51 E	1686	1735	3173	B. cl
305	75 1	7 56 E	1545	1590	2908	B. cl
306	75 0	10 27 E	1296	1334	2440	B. cl
307	74 58	12 10 E	1181	1216	2224	B. cl
308	74 57	12 43 E	1104	1136	2078	B. cl
309	74 57	13 18 E	1035	1065	1948	br. cl
310	74 56	13 50 E	977	1006	1840	br. cl
311	74 55	14 25 E	872	898	1642	br. cl
312	74 54	14 53 E	639	658	1203	gy. cl
313	74 55	15 49 E	198	204	373	gy. cl
314	74 55	15 21 E	494	509	931	gy. cl

Stat. No.	Nordlig Bredde. (North Latitude.)	Længde fra Greenwich. (Longitude from Greenwich.)	Dybde (Depth.) N. Favne. (Norw. Fths.)	E. Favne. (Fathoms.)	Meter. (Metres.)	Bund. (Bottom.)
315	74° 53.'	15° 55.' E	175	180	329	h. cl. s
316	74 56	16 29 E	125	129	236	b. cl
317	74 56	16 52 E	96	99	181	d. gy. cl
318	74 56	17 39 E	53	55	101	d. gn. cl
319	74 57	18 22 E	44	45	82	r
320	74 57	19 8 E	30	31	57	r
321	74 56	19 30 E	24	25	46	r
322	74 57	19 52 E	20	21	38	r
323	72 53	21 51 E	217	223	408	br. gy. cl
324	73 47	20 48 E	226	233	426	gy cl
325	74 2	20 30 E	87	90	165	d. gn. cl
326	75 31	17 50 E	119	123	225	d. cl
327	75 39	16 33 E	183	188	344	gn. cl
328	75 42	15 39 E	194	200	366	gy. cl
329	75 45	14 45 E	193	199	364	d. cl
330	75 48	13 54 E	431	444	812	d. cl
331	75 51	13 5 E	772	795	1454	red cl
332	75 56	11 36 E	1116	1149	2101	B. cl
333	76 6	13 10 E	727	748	1368	B. cl
334	76 12	14 0 E	392	403	737	d. cl
335	76 17	14 39 E	174	179	327	d. cl
336	76 19	15 42 E	68	70	128	h. cl
337	76 23	16 43 E	19	20	37	r
338	76 19	18 1 E	142	146	267	r
339	76 30	15 39 E	36	37	68	r
340	76 31	14 40 E	56	58	106	cl
341	76 32	13 53 E	115	118	216	r
342	76 33	13 18 E	508	523	956	d. gy. cl
343	76 34	12 51 E	722	743	1359	cl
344	76° 42.'	11° 16.' E	988	1017	1860	d. cl
347	76 40	7 47 E	1388	1429	2613	B. cl
349	76 30	2 57 E	1445	1487	2719	B. cl
350	76 26	0 29 W	1638	1686	3083	B. cl
351	77 49	0 9 W	1593	1640	2999	B. cl
352	77 56	3 29 E	1638	1686	3083	B. cl
353	77 58	5 10 E	1295	1333	2438	B. cl
354	78 1	6 54 E	1305	1343	2456	B. cl
355	78 0	8 32 E	921	948	1734	cl
356	78 2	10 19 E	107	110	201	b. cl.
357	78 3	11 18 E	121	125	229	gn. cl
358	78 2	9 46 E	90	93	170	cl. g.
359	78 2	9 25 E	404	416	761	b. gy. cl
360	78 47	6 58 E	409	421	770	h
361*	79 8	5 28 E	879	905	1655	B. cl
362*	79 59	5 40 E	446	459	839	b. cl
363	80 3	8 28 E	253	260	475	b. cl
364	79 48	10 50 E	189	195	357	sh
365	79 34	11 25 E	72	74	135	d. gy. cl
366	79 35	11 17 E	59	61	112	d. gy. cl
367*	78 44	7 46 E	520	535	978	cl
368*	78 43	8 20 E	306	315	576	b. cl
369*	78 42	8 53 E	84	87	159	st. cl
370*	78 48	8 37 E	106	109	199	gy. cl
371	78 8	13 46 E	191	197	360	gy. cl
372	78 9	14 7 E	125	129	236	d. cl
373	78 10	14 21 E	117	120	219	d. cl
374	78 16	15 33 E	58	60	110	d. cl
375	75 30	15 3 E	198	204	373	d. cl

* Paaværende Plads usikker, muligens 4'—5' sydligere.

Position doubtful; possibly from 4 to 5 Miles farther South.

Temperatur-Rækker.

Til Undersøgelse af Temperaturen i forskjellige Dybder paa samme Station toges Temperatur-Rækker. Disse udførtes i Regelen saaledes: Rørloddet hexedes i Lodlinen, og lige ovenfor Loddet fastgjordes et Dybvandsthermometer, ganske som ved Lodning. Indhivningsmaskinen udfiredes 100 Favne, og Thermometer No. 2 gjordes fast i Lodlinen fra Loddebroen. Atter udfiredes det andet 100 Favne og Thermometer No. 3 paasattes Linen. Paa denne Maade anbragtes 5 a 6 Thermometre paa Linen med 100 Favnes Afstand og sænkedes ved Udfiring fra Indhivningsmaskinen til de Dybder, i hvilke man vilde maale Temperaturen. Naar alle Thermometre havde faaet Tid til at accommodere sig, haledes Linen ind med Maskinen. Der stoppedes saa lang Tid, som var nødvendig for at løse Thermometrene fra Linen, efterhvert som de kom op. Der lagdes megen Vind paa jevne Bevægelser under disse Operationer, for ikke at udsætte Indexthermometrene for pludselige Ryk eller Stød. I høj Sogang maatte der benyttes megen Forsigtighed ved Thermometrenes Aftagning af Linen. Fartøjet laa i Regelen, som ved Lodning, med Stevnen mod Søen, men man kunde ikke altid holde Lodlinen saaledes, at den kunde naaes med Haanden fra Loddebroen. Linen maatte da bringes ind til Broen ved Hjælp af en Baadshage, der maatte gribe Linen *under* Thermometret for ikke at komme til at berøre dette.

Temperaturrækkerne udførtes kun meget faa Gange ved at lade Linen løbe ud fra Rullen, da dens Standsning let medførte Ryk, som ialfald Indexthermometre ikke maa udsættes for.

Temperaturrækker paa Dybder mindre end 50 Favne udførtes ofte med Haandlod og Haandline, der havde Mærker for hver 5 eller 10 Favne.

Temperaturrækkerne toges i Almindelighed strax efter et Lodskud. Flere Gange blev der dog efter Lodskuddet arbejdet med Skrabe eller Trawl, naar saadant faldt belejligere, og Temperaturrækken toges da efter at disse Arbejder var færdige. Paa denne Maade er det gaaet til, at Temperaturrækkens paaværende Plads undertiden er lidt forskjellig fra Lodskuddets.

Varigheden af en Temperaturrække er naturligvis forskjellig efter Antallet af Dybder, hvori Temperaturen tages og efter Dybdernes Størrelse. En Statistik, taget af Skibsjournalen, viser, at der til *Lodskud og Temperaturrække* medgik omtrentlig:

Paa et Dyb af 100 Favne	30 til 50 Minutter.
- - - - 500 —	1 Time 40
- - - - 1000 —	2 Timer 30 —
- - - - 1500 —	3 —
- - - - 2000 —	3 — til 3 Timer 30 Minutter.

Serial Temperatures.

For determining the temperature of the sea in different depths at the same observing-station, we took series of temperatures. Our mode of operation was generally as follows: — After shackling the tube-lead to the sounding-line, we attached, just above the weight, a deep-sea thermometer, precisely as for ordinary soundings. Then, 100 fathoms of line were veered out with the donkey-engine, and Thermometer No. 2 made fast, from the sounding-bridge, at the first hundred-fathom slip, after which we veered another 100 fathoms, and attached Thermometer No. 3 to the line at the second slip. In this manner, as many as 5 or 6 thermometers were made fast to the sounding-line at intervals of 100 fathoms, and sent down to register the temperature in the desired depths. So soon as the thermometers had had time to take the temperature of the surrounding water, we started the donkey-engine and began hauling in the lead, stopping, as each of the thermometers came up over the rail of the bridge, to detach it from the line. Very great importance was attached to uniformity of motion pending these operations, so as not to expose the index-thermometers to any sudden jerk or shock. In a heavy sea, we had to be specially careful when taking the thermometers off the line. The ship generally lay head to sea, as she did during the descent of the lead; nevertheless, we sometimes found it impossible to keep the line within reach from the sounding-bridge, in which case it was got in with a boat-hook, care being taken to hook the line below the thermometer, and thus avoid coming in contact with the latter.

Only a few serial temperatures were taken by letting the line run out of itself, the necessary stoppages in that case easily occasioning jerks, to which the index-thermometers, at least, must not be exposed.

At depths of less than 50 fathoms, serial temperatures were frequently taken with the hand-lead, the line being graduated into fives or tens of fathoms.

As a rule, we took our serial temperatures immediately after sounding. On several occasions however, the dredge or trawl was worked in preference, the serial temperatures being in that case deferred till we had terminated those operations. This accounts for the position in which certain of the serial temperatures were taken differing slightly from that of the soundings.

The time required to take a serial temperature will obviously depend alike on the depth and the number of temperatures. Data obtained from the ship's log-book show the time occupied in taking a sounding and a serial temperature to have averaged as follows: —

For a Depth of 100 Fathoms	from 30 to 50 minutes.
- - — - 500 —	1 hour 40 minutes.
- - — - 1000 —	2 hours 30 —
- - — - 1500 —	3 —
- - — - 2000 —	from 3 hours to 3 hours 30 minutes.

I de dybere Lag, under 600 Favne, toges sjælden Temperaturrækker, da Vandets Temperatur her kun varierede fra 0° til —1.°5.

Bundskrabning.

De Apparater, som brugtes til at hente Dyr op fra Havbunden, var Skraber, Svabere og Trawls.

Skrabe. — Dette Apparat var gjort efter engelsk Mønster. Skrabemunden bestaar af en smedet Jernramme, hvis Længde er omtrent 7 Gange saa stor som Bredden. Til denne er fæstet en Pose eller Sæk, og det hele drages langs Havbunden, idet Munden med sin nederste lange Læbe afskraber det øverste Lag af denne og dermed de deri værende Sødyr.

Af *Skraber* for større Dyb havde vi 3 Størrelser. Paa den største, fremstillet i Fig. 17, var Læbernes Længde 1m.25 (4 Fod), paa den mellemste 0m.94 (3 Fod) og paa den mindste 0m.78 ($2^1/_2$ Fod). Paa alle 3 var Formen af *Skrabemunden* den samme. Med den oprindelige Form, som Skraberne havde, da de kom fra England, fandt vi, at de tog for Lidet af Bunden, og selv efter lang Skrabning var der altid meget lidet i dem. Medens Expeditionen laa i Thorshavn i Begyndelsen af Juli 1876 og udbedrede den

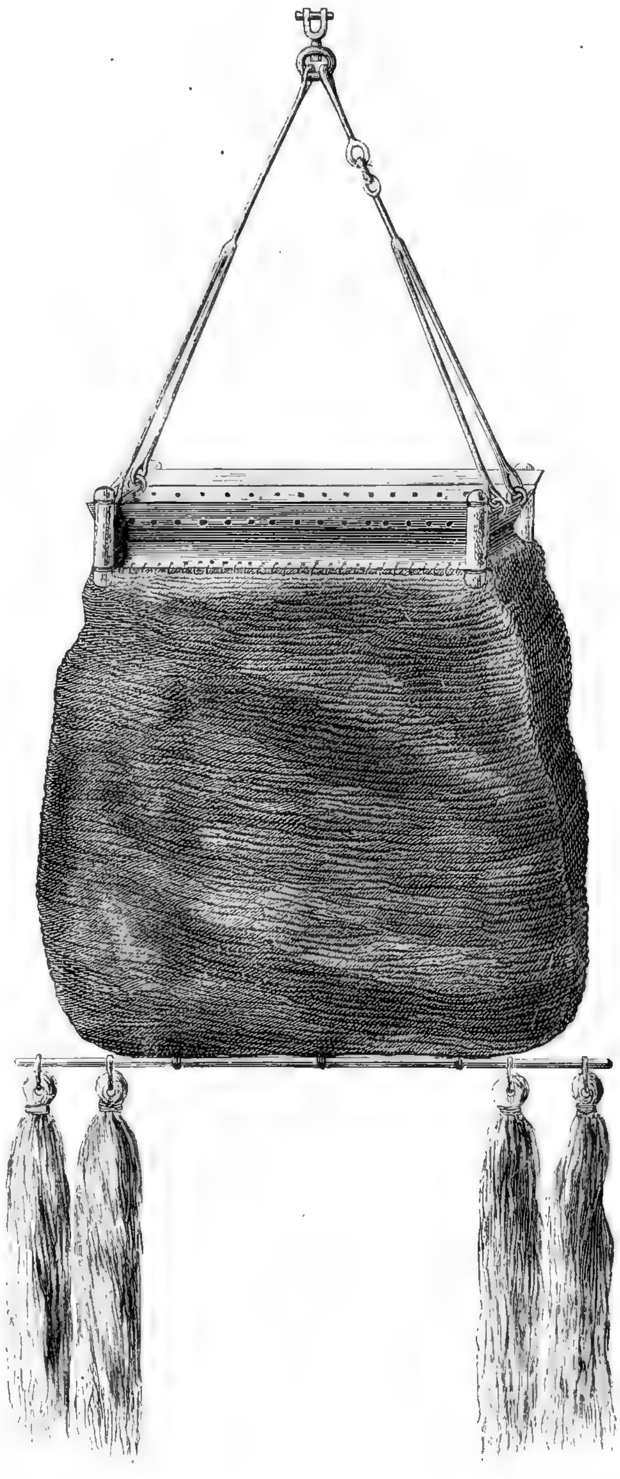

Fig. 17.

At depths exceeding 600 fathoms we seldom took serial temperatures, the temperature in the deeper strata varying only from 0° to — 1°.5.

Dredging.

The apparatus employed on the Expedition for bringing up animals from the bottom of the sea comprised the dredge, the trawl, and swabs.

The Dredge. — This instrument was on an English pattern. The frame is of hammered iron, the length at the mouth being to the width as 7 to 1. From the frame is suspended a bag, into which, on the dredge being dragged over the bottom, the long nether lip of the mouth will scrape in the substance of the surface, along with the marine animals it contains.

For greater depths, we had dredges of three different sizes. In the largest (Fig. 17), the length of the lips, or scrapers, was 4 feet, in that of medium size 3 feet, and in the smallest $2^1/_2$ feet. The shape of the *mouth* was the same in all three.

These instruments, which had been made in England for the Expedition, did not, we found, as originally constructed, bring up a fair sample of the bottom; the freight was invariably small, even after protracted dredging. We therefore, when refitting at Thors-

lidte Søskade, benyttede vi Anledningen til at give Læberne en hensigtsmæssigere Form, idet der udenpaa den oprindelige Læbe paaklinkedes tyndere Jernlæber, der rakte 3.9 cm. ($1^1/_2$ Tomme) frem foran de gamle. Mundingen blev herved ogsaa noget videre, da de nye Læber havde en divergerende Stilling udad, foruden at Læberne blev skarpere. I Fig. 17 ser man dem afbildet. Denne Anordning viste sig strax som en Forbedring. Det hændte dog undertiden, at Læberne greb altfor dybt, saaledes at Skraben i kort Tid fyldte sig med Bundmaterialet, istedetfor kun at skumme det Øverste af dette af og først efter længere Tids Skrabning at fylde Sækken. Denne Ulempe hævedes dog snart ved Anbringelsen af et Par korte Træmejer, som er viste i Figuren, paa begge Sider af Skrabens Jernramme. Mejerne var 4 til 5 Centimeter ($1^1/_2$ til 2 Tommer) brede og af lidt større Længde end Jernrammens Højde, paa Ydersiden og for begge Ender afrundede, og fastgjorte henimod sine Ender med Surringer dels til Jern-Hanefoden dels til den Kant af Skraberammen, hvor Sækken var fastsyet. Forenden rakte ganske lidt foran (i Figuren over) Læbernes Yderkant.

Sækken var af Kokostougverk, lagt som Matte. Den var syet til Skrabens Jernramme paa dennes Under- eller Bagside, og desuden sammensyet paa Siderne som vist i Figuren, saaledes at den let kunde aabnes og Indholdet lægges frit i Dagen.

Skraben var, saaledes som Figuren viser, forsynet med en *Hanefod*, i hvilken Skrabetouget blev fastgjort. Hanefoden var af Jernstænger, med dobbelt Part i den Skraben nærmeste Del, og fæstet til Skraberammen med stærke Ringe, der gik gjennem Huller i denne og gjennem Hanefødens Øjebolt. Den ene Side af Hanefoden bestod i Forhaand af 2 Dele, der endte i Øjebolte, som var forbundne med en Fangning af Skibmandsgarn. Denne var beregnet paa at springe, dersom Skraben stødte paa en større Hindring paa Havbunden, som kunde holde den fast, naar begge Hanefødens Arme trak i Skraben. Med alene den ene Arm som Drag, kunde man i mange Tilfælde gjøre Regning paa at faa Skraben halet rundt Hindringen og løs.

Til Sækkens Bund var fastgjort en Jernstang, til hvilken, ud imod dens Ender, nejedes 2 *Svabere* paa hver Side. Disse Svabere var af heglet Hamp, noget over 1^m (3 Fod) lange. Mange Dyr, som ikke eller i lidet Antal kom ind i Skrabesækken, hang fast ved Svaberne, der saaledes var, for visse Dyrearter, et udmærket Fangstapparat.

Enkelte Gange, paa meget ujevn Bund, hvor man vilde risikere at faa Skraben iturevet, brugtes Svabere alene, fæstede til en Jernstang, der med Hanefod var fæstet til Skrabetouget.

havn in the beginning of July 1876, took advantage of the opportunity afforded to modify the construction of the apparatus, with the object of remedying the above-mentioned defect, in which we succeeded, by rivetting on to the outer surface of the scrapers another, but thinner pair (Fig. 17), projecting an inch and a half beyond the former. In this way greater width was given to the mouth of the dredge, the additional pair of scrapers being made to diverge from each other; moreover, they had sharper edges. Our modification turned out a decided improvement. Now and again, however, the scrapers would cut too deep, and soon fill the dredge-bag with matter from the bottom, instead of skimming off a thin layer from the surface and gradually freighting the apparatus. But this drawback we got rid of by fixing to the frame of the dredge, as shown in the figure, a couple of wooden runners, one on either side. These runners had a width of $1^1/_2$—2 inches, and slightly exceeded in length the height of the frame; they were rounded on the outer side and at both ends, and were lashed, near their extremities, to the iron crow-foot, and to the end of the dredge-frame from which the bag depended. The fore part projected a very little beyond the edges of the scrapers.

The *Dredge-bag* — of strong cocoa-nut matting — was suspended from the lower end of the frame, and fastened together at the sides in such manner as to admit of being readily opened to expose its contents.

The dredge, as shown in the figure, was made fast to the dredge-rope by means of a *crow-foot*, consisting of iron rods, two-armed in the part nearest the dredge, and attached to the dredge-frame by strong iron rings, that passed through holes in the frame and through the eyes of the crow-foot. One arm of the crow-foot was in two parts terminating in eyebolts, connected together by a stop of spunyarn, so that in case the dredge got jammed among rocks and stones, a strain less than sufficient to break the dredge-rope would part the stop, alter the position of the dredge, — which would then be attached to the rope by only one arm of the crow-foot, — and probably enable it to free itself.

To the bottom of the dredge-bag was attached a long tranverse iron bar, with a couple of "swabs," or rather bunches of teazed-out hemp, about 3 feet in length, fastened at each of the free ends. Animals that never entered the dredge-bag, or, at best, but rarely and few in number, came up again and again on the tangles, which seem to be singularly well adapted for the capture of certain kinds of marine animals.

Once or twice, on a bottom exceptionally rugged, involving the risk of the dredge being torn or broken, we sent down the tangles alone, attached to an iron bar, which by means of a crow-foot was made fast to the dredge-rope.

Af *Trawls* havde vi 2 Slags, begge leverede af Dr. J. Hearder & Son i Plymouth, nemlig Otter-Trawl og Bom-Trawl.

Of *Trawls* we had two kinds, viz. the Otter-trawl and the Beam-trawl, both furnished by Dr. I. Hearder & Son of Plymouth.

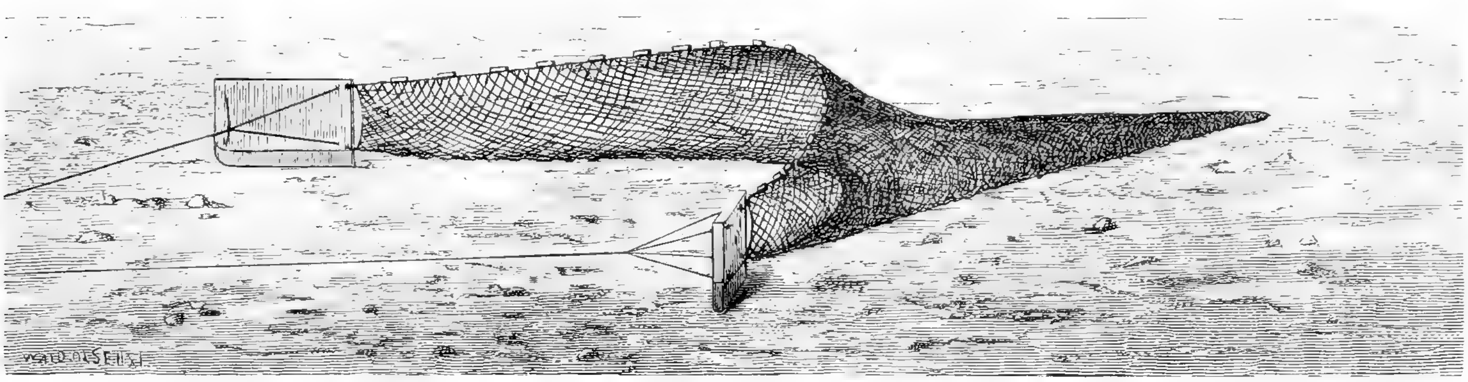

Fig. 18.

Otter-Trawlen (Fig. 18) er nærmest et Fiskeapparat og ikke særdeles meget skikket til zoologisk Brug: Det bestaar af et Net, der er aabent foran og bagtil snevrer sig sammen til en Spids. Til Netmundingen er fastgjort 2 Ottere eller firkantede Træplader, 0.^{m}63 (2 Fod) høje, hvis Underkanter er belastede med Jernmejer. Enderne af Hanefoden, der forbinder Skrabetouget med Trawlen, er fastgjort til Stropper paa Indersiden af disse Ottere, saaledes at de under Farten ved Vandtrykket skjærer ud til hver Side. Overkanten af Netmundingen holdes oppe ved Korkstykker, medens Underkanten er belastet med Blystykker. Netmundingen er 7^m.5 (24 Fod) bred mellem Otterne, og Posens hele Længde er 6.^{m}3 (20 Fod).

Naar Otterne skal komme i Stilling, maa dette Apparat gives saa stor Fart gjennem Vandet, at det paa Grund af Tougets Visning paa større Dybder er udsat for at løftes fra Bunden.

The *Otter-trawl* (Fig. 18) is properly a fisherman's apparatus, and not very well adapted for scientific purposes. It consists of a long conical bag of cord-netting, to the mouth of which are attached two "otters," or quadrangular pieces of wood, 2 feet square, each weighted on the lower part with an iron runner. The ends of the crow-foot connecting the trawl with the dredge-rope are secured to straps on the inner side of the otters, in such manner as will cause the latter, when in motion, to sheer out, or diverge, from the action of the water. The top side of the mouth of the net is kept in position by pieces of cork, the under side being weighted with rolls of sheet-lead. The length of the trawl-bag is 20 feet, and its width at the mouth, measured between the otters, 24 feet.

To give the otters the right position, the trawl must move through the water with a rapidity that, by reason of the oblique direction of the dredge-rope, will easily cause the apparatus to be lifted from the bottom.

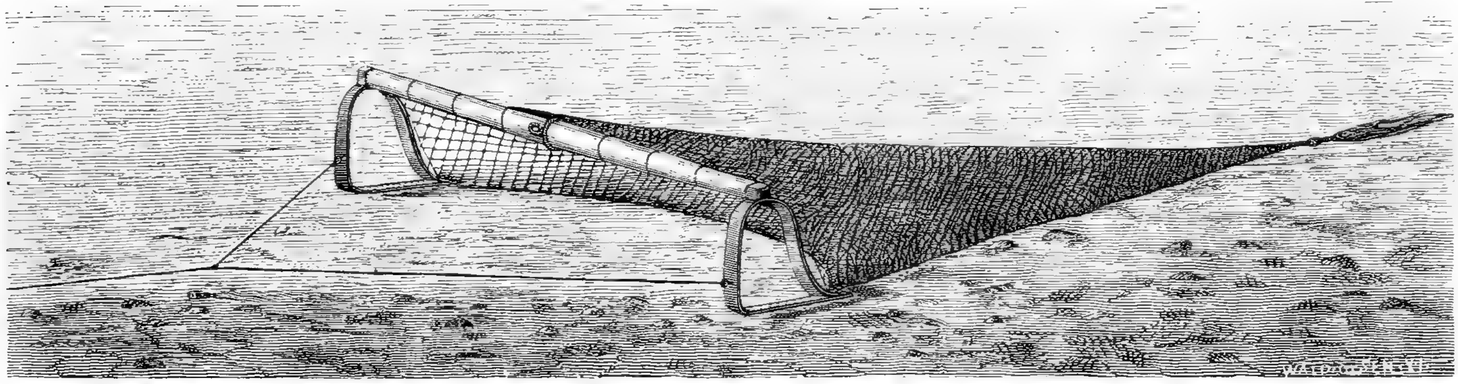

Fig. 19.

Bom-Trawlen (Fig. 19) bestaar af et poseformet, mod Bagenden spidst indsnævret Net, hvis Mundings Overkant er fastgjort til en, 4.m7 (15 Fod) lang, rund Bom af Træ, paa hvis firkantede Ender er indsmoget Jernmejer, 0m.8 ($2^1/_2$ Fod) høje, paa hvilke Apparatet kjøres langs Havbunden. Trawlens Længde fra Midten af Bommen til Spidsen af Nettet er 6m.5 (21 Fod). Den med Blystykker belastede, noget slakke Underkant af Netmundingen er i sine Ender fæstet til Mejernes Underdel og slæber langs Bunden mellem disse, idet den graver mere eller mindre dybt ned i Bundens Materiale. Gjennem en Hanefod af Tougverk, der er fæstet i Øjebolte paa Forkant af Jernmejerne, staar Trawlen i Forbindelse med Skrabetouget. Til Mejerne og til Netspidsen fæstedes ofte Hampsvabere.

Maskerne i Nettet var oprindelig temmelig aabne, saaat det kun kunde holde større Gjenstande tilbage, medens mindre Dyr og det fine Slam gik igjennem. Efter Professor Sars's Ønske blev derfor Spidsen af Nettet foret med finmasket Garn, saaledes at det kunde holde fint Slam. Med denne Forbedring var efter vor Erfaring Bom-Trawlen et udmærket Bundskrabningsapparat. Den fangede baade under hurtigere og langsommere Bevægelse langs Bunden og tog ikke alene Fiske og andre Dyr, der bevæger sig frit i Nærheden af Bunden, men den skummede ogsaa det øvre dyrholdige Bundmateriale af, ja tog endog Stene og det store, indtil 50 Kilograms (100 Pd.) Vægt ind i Nettet.

Bom-Trawlen havde i sin oprindelige Skikkelse ogsaa den Fejl, at hele Systemet kunde svinge sig rundt i Vandet under Udfiringen, og Apparatet kunde saaledes undertiden falde paa Ryggen, med Bommen ned, paa Havbunden. Denne Mangel blev rettet af Skibsfører Grieg ved at hænge et Lod i slak Bugt mellem Mejerne. Fig. 20 viser dette Arrangement. Naar Trawlen begynder at helde fra den rigtige Stilling, i hvilken den blev sendt ud, afslakkes den Del af Touget, der var fast i den Mej, som var nederst, Loddet trak i den anden Part alene og drog den Ende, som var øverst, ned til samme Højde som den anden.

Til *Skrabetoug* brugtes 5 centimeters (2 Toms) Toug de første 2000 Favne og 6.5 centimeters ($2^1/_2$ Toms) i Agterhaanden. Begge Slags var af bedste Sort russisk Hamp, og Prøvetrosserne besigtigede og prøvede ved Carl-Johansværns Værft.

Forberedelser til Bundskrabning. — Disse begyndte i Regelen strax efter at man var færdig paa Bagbord Side med Lodning eller Temperaturrække.

For at compensere Virkningen af Skibets og Skrabens Bevægelse paa Strammingen af Skrabetouget, navnlig for at undgaa farlige pludselige Ryk, var Skrabetouget vist gjennem en Blok, der hang i en *Accumulator*. Skrabeaccumulatoren var meget større end Loddeaccumulatoren. Den havde 30 Stropper, af samme Slags som de ved Lodningen benyttede. Træskiverne, gjennem hvilke Tougstjerterne gik, havde en Diameter af 0m.605 (1 Fod $11^1/_2$ Tomme) og en Tykkelse af 0m.050 (1.9 Tomme). Skrabeblokken var af

Fig. 19 represents the *Beam-trawl* used on the Expedition. A conical netted bag is suspended by one side from a round beam of wood 15 feet in length, to the square ends of which are fixed iron runners, 2 feet and a half high, that support the apparatus when riding over the bottom. The length of the trawl, measured from the middle of the beam to the apex of the bag, is 21 feet. The lower side of the mouth of the net, weighted with rolls of sheet-lead, hangs loose, and is fastened at either end to the bottom part of the runners, between which it drags along the sea-floor, scooping up more or less of solid matter. This trawl is attached to the dredge-rope by means of a rope crow-foot, lashed to eyebolts on the fore part of the iron runners. We often fastened hempen tangles both to the runners and to the end of the bag.

The commercial trawl, as furnished by the English maker, had a rather wide-meshed bag; and hence it brought up none but comparatively large bodies, small animals and fine mud being washed through. At the instance, therefore, of Professor Sars, the bottom of the bag was lined up to a certain height with yarn netting, sufficiently close to retain the finest mud. With this slight modification, we found the beam-trawl a most efficient instrument, whether quickly or slowly worked; it not only secured fishes and other marine animals that occur near the bottom, but skimmed off a thin layer of the surface; nay, it would take in stones, some of them weighing as much as 100 pounds.

In its original form, the beam-trawl was apt moreover to capsize in the water and reach the bottom with the beam down. Captain Grieg remedied this defective tendency by suspending one of the cast-iron sinkers in a slack bight between the runners. This arrangement is shown in Fig. 20. So soon as the trawl begins to incline from the right position given it at the commencement of the operation, the part of the rope made fast to the runner then deepest in the water will get slack, and the weight accordingly act only upon the runner at the opposite end of the beam, pulling it down to a level with the lower one.

The *Dredge-rope*, samples of which had been examined and tested at the Royal Dockyard of Carljohansværn, was of the best Russian hemp. The 2000 fathoms next the dredge were 2 inches in circumference, the remainder had a circumference of $2^1/_2$ inches.

Preparations for Dredging. — As a rule, the gear was got ready immediately after taking — on the port side — a sounding or a serial temperature.

With a view to take off the suddenness of the strain on the rope caused by the scraping of the dredge or the motion of the vessel, the rope was rove through a block suspended to an *accumulator*. The accumulator provided for the dredge exceeded considerably in size that used with the sounding-machine. The number of straps was 30, and the wooden disks through which the lanyards passed had a diameter of 1 foot $11^1/_4$ inches and a thickness of 2 inches. The dredging-block was of iron, similar in con-

Jern og forøvrigt af lignende Konstruktion som Loddeblokken. Skiven, der var solid, havde en Diameter af 0m.521 (1 Fod 8 Tommer), en Tykkelse af 0m.15 (5¾ Tomme), og Furens Dybde var 0m.079 (3 Tommer). Skrabeaccumulatoren hang paa Styrbord Side, *i et Topreb*, hvis øvre Ende var fastgjort til Stormasten over Godset. Fig. 14 viser Accumulatoren hængende i Styrbords Vant, hvor den havde sin Plads, naar den ikke benyttedes til Skrabning.

Skraben eller Trawlen gjordes klar paa Agterdækket mellem Nedgangskappen til Lugarerne og Kappen ved Siden af Dækrullen (Fig. 1, Fig. 2, Fig. 14). Skrabetouget, der laa i sine Binger (Fig. 2, b) agtenfor Fokkemasten, og som i Tampen havde Kous og Hex, toges gjennem en Kasteblok paa Fokkemasten (se Fig. 20), derfra over Hytten og gjennem Kasteblokken i Accumulatoren, og hexedes i Hanefoden til Skraben eller Trawlen. Paa Skrabetouget var indsmøget en Pukkenholts Dor eller Kous med en lang Stjert. Dens Plads var mellem Skrabeblokken og Skraben (Trawlen). Accumulatoren udhaltes med firskaaren Talje (Fig. 14) paa Plads under Styrbords Storraanok. Raaen brasedes saaledes, at Accumulatoren hang omtrent midt ud for Loddebroen. (Fig. 1, Fig. 20). Da der ved Skrabningen kunde gaa stor Kraft paa Raaen saavel nedad som indad, var den paa Styrbord Side fastøttet, foruden ved Toplent, Rakke og Braser, ogsaa ved en Talje som Extra-Toplent og en Støttalje paa Bagbord Side, som Fig. 14 viser.

Manøvrerne ved Bundskrabning var ikke meget forskjellige, enten man brugte Skrabe eller Trawl. For Tydeligheds Skyld skal de her særskilt beskrives, forsaavidt nødvendigt er.

Bundskrabning med Skrabe. — Skibet sattes med fuld Fart op mod Vinden med denne lidt ind om Styrbord. Naar det var kommet i godt Sig, standsedes Maskinen, Skraben løftedes ud over Rækken med Haandmagt og kastedes i Vandet. Forud ved Fokkemasten stod en Mand, med Læderhandsker paa Hænderne, færdig til at fire ud paa Skrabetouget, assisteret af en anden Mand, der ved Hjælp af en Haandspage holdt Touget klart til at løbe fra Kvejlen i Bingen. Strax Skraben var i Vandet, kommanderedes: "Fir"! og man firede langsomt paa Skrabetouget, saa man kunde se, om alting var klart. Naar Skraben var agtenfor Skruen, sattes denne atter igang til 4 Knobs Fart, som Maskinisten holdt jevn ved at observere Vandloggen. (Se nedenfor). Man firede nu, med jevnlige Anhold, for at holde Touget og Apparatet strakt, stadig under samme Kurs, som da Skraben kastedes overbord. Naar 200, 300 eller 400 Favne, efter den mindre eller større Dybde, var udfirede, standsedes atter, Touget haledes ved Hjælp af Kousen og Stjerten ind til Hakkebrættet, og der paasattes en Trætærs ved Hjælp af Skibmandsgarnsurring, agtenfor Kousen. Der sattes atter i Gang med samme Kurs og Fart, og man sejlede ud den hele Touglængde, der ansaaes fornøden, nemlig mindst det dobbelte af Dybden og for mindre Dybder mere.

struction to the sounding-block. The sheaf, which was solid, had a diameter of 1 foot 8½ inches and a thickness of 6 inches; the depth of the groove was 3 inches. The accumulator used for the dredge hung — on the starboard side — in a *pendant*, the upper end of which was secured to the mainmast above the rigging. Fig. 14 represents this accumulator as it hung suspended in the starboard shrouds when not in use.

The dredge and the trawl were got ready on the after-deck, between the companion-hatchway to the cabins and the hatchway alongside of the reel (Figs. 1, 2, and 14). The dredge-rope, which at one end had a thimble and shackle, was rove from the lockers (Fig 2 b) in which it lay coiled abaft the fore-mast, through a snatch-block on the mast (Fig. 20), carried from thence over the roof of the roundhouse and through the snatch-block of the accumulator, and then shackled to the crow-foot of the dredge or trawl. Between the dredging-block and the dredge (or trawl) a thimble of lignum vitæ, with a lizard, was slipped on to the dredge-rope. The accumulator was triced up under the starboard main yard-arm by means of a guntackle purchase, the yard being trimmed so as to bring the accumulator nearly abreast of the sounding-bridge (Figs. 1 and 20). As the strain, inwards as well as downwards, to which the yard was exposed when dredging, might be very considerable, it was secured, not only by braces, lifts, and trusses, but also, on the starboard side, by a purchase, as a preventer-lift, and on the port side, by a rolling-tackle, as shown in Fig. 14.

Dredging and Trawling from the "Vøringen." Both operations were conducted very much alike. We shall, however, for the sake of perspicuity, describe our mode of working each of the two instruments.

Working the Dredge. — We steamed full speed ahead, with the wind a little on our starboard bow. So soon as the vessel had got sufficient headway, the engine was stopped, the dredge lifted by hand over the railing and dropped into the sea. At the foremast, a man with thick leather gloves stood ready to pay out the dredge-rope, which another kept clear with a handspike as it ran out from the coil in the locker. On the dredge entering the water, the word was immediately given to veer, when the paying out commenced, — slowly, however, to make sure that all was right. So soon as the dredge was clear of the propeller, the vessel again went ahead, steaming at a uniform rate of 4 knots, which the engineer was enabled to keep up by frequent reference to the water-log (see below). Meanwhile, we kept steadily veering, while taking care, by frequent holding on to the rope, that the length run out should be properly taut, and steering the course given to the ship when the dredge was put over. After paying out, according to depth, 200, 300, or 400 fathoms, we again stopped, hauled in the rope to the taffrail by means of the lizard and thimble, and fastened, below the latter, with spun-yarn, a wooden toggle to the rope. Starting again (same course and speed), we next ran out the whole length of rope deemed necessary for the operation. —

Farten standsedes. Med Stjerten haledes Skrabetouget atter ind til Hakkebrættet og holdtes inde med Bugten af en Ende. Til Stjerten i Pukkenholtskousen fastgjordes en efter Dybden afpasset Vægt, hvortil brugtes 3 eller 4, til de større Dybder 6 af Baillie-Maskinens Lodder, der vejede 27 Kilogr. (55 Pd.) hver. Man slap Tampen af Enden, væltede Vægten overbord, og denne løb da med Kousen nedover langs Touget, indtil den standsedes af den paasatte Trætærs. Dette kunde føles, naar man holdt Haanden paa Touget.

Skibet laa nu stille, medens Lodder og Skrabe sank. Vi regnede, efter flere Forsøg, at der behøvedes 12 Minutter for at Skraben skulde synke 100 Favne. Skrabens (eller rettere Trawlens) og Loddernes Synkning er anskue-

not less than double the depth, nay for smaller depths even more.

The engine was now stopped, after which we hauled in the dredge-rope, as before, to the taffrail, and kept it up in a bight of rope's end. With the lizard was then made fast to the wooden thimble a weight proportioned to the depth, consisting of 3 or 4, and for the deepest dredgings, of as many as 6 of the sinkers of the Baillie sounding-machine, weighing each 55 pounds. We now, after letting go the rope, tilted the weight overboard, which spun down along it till stopped by the wooden toggle. The shock of its arrest was distinctly perceptible to a person who had his hand on the rope.

The vessel was now kept stationary, while the weight and the dredge were sinking. After some experience, we calculated the time required for the dredge to sink 100 fathoms, to be about 12 minutes. Fig. 20 will

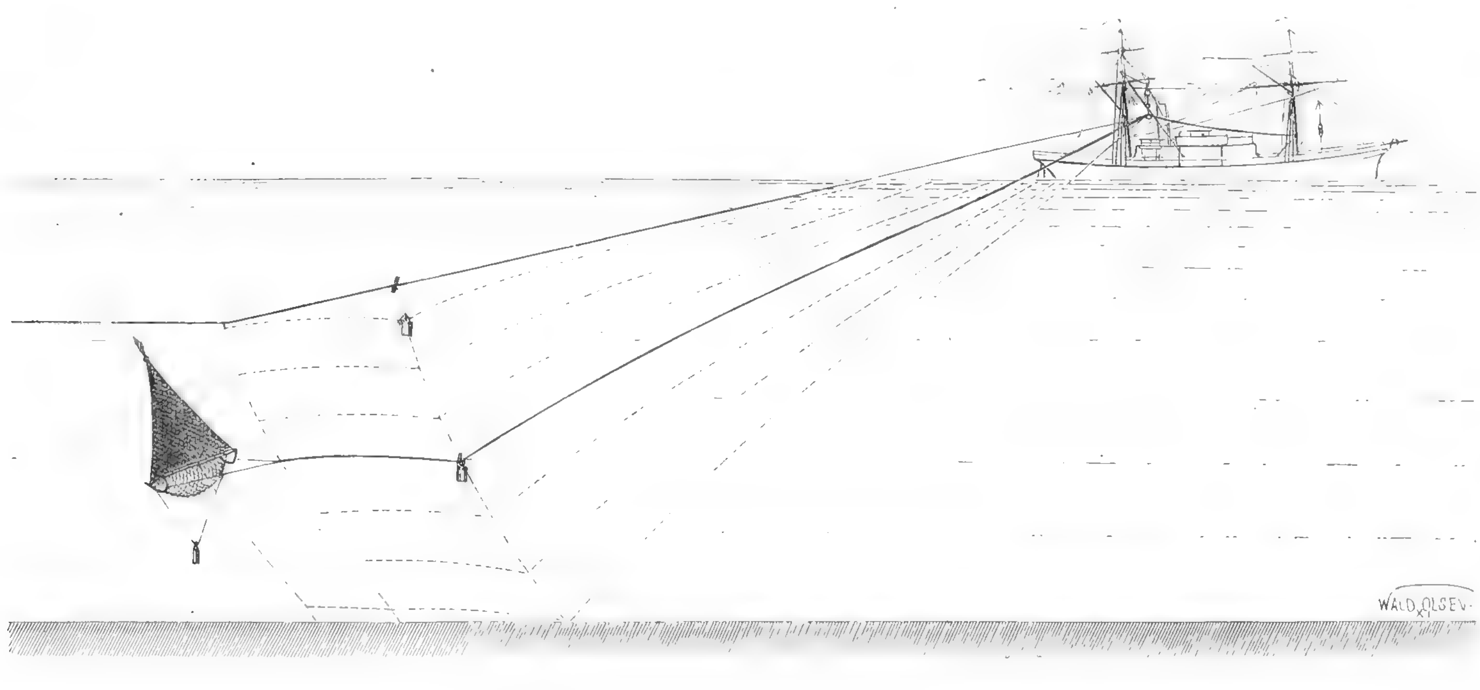

Fig. 20.

liggjort i Fig. 20. Den i Figuren antagne Dybde er 1300 Favne, følgelig er Skib og Trawl tegnet i forstørret Maalestok. De prikkede Linier viser Loddernes, Skrabetoughexens og Trawlbommens Bane under Synkningen, under Forudsætning af, at Trawlen synker med en Hastighed, der er lidt mindre end den, hvormed Lodderne nærmer sig Bunden. Idet Lodderne naar Bund, svæver endnu Trawlen i Vandet, og det sidste Stykke af dens Bane vil være næsten lodret. Erfaring viste, at Trawl og Skrabe med den brugte Fremgangsmaade i Regelen uden Vanskelighed kom i rigtig Stilling paa Bunden. Er Skrabens (Trawlens) Synken meget langsommere end Loddernes, vil den falde lodret ned paa Bunden med sin tunge Ende foran. Er derimod dens Syn-

give an idea of the descent of the dredge, or rather of the trawl. The supposed depth in the diagram being 1300 fathoms, the vessel and the trawl are of course on a much larger scale. The dotted lines represent the lines of descent of the weight, the shackle, the dredge-rope, and the beam of the trawl, — assuming the trawl to sink more slowly than the weight. When the weight strikes the bottom, the trawl has still some distance to travel, and the last part of its line of descent will be well-nigh perpendicular. We found that, when worked in the manner described above, both trawl and dredge could as a rule without difficulty be made to reach the bottom in the right position. If the dredge or trawl descend much more slowly

ken ligesaa hurtig som Loddernes eller hurtigere, vil den komme til Bunds med en horizontal Component i sin Bevægelse, hvilket vistnok vilde være det sikreste Middel til at den blev klar under den følgende Bundskrabning.

Saasnart Skraben antoges at have naaet Bund, kastedes Touget los forud og Bugten bragtes agterover, lagdes ind i Fodblokken (a, Fig. 2) i Agterkant af Hytten og derpaa om Spiltapperne om Styrbord, saaledes som Fig. 1 viser.

Med 1, $1^1/_2$ og 2 Knobs Fart og samme Kurs som tidligere blev nu Skraben trukket henover Havbunden, idet Vægten i Forhaand holdt den første Del af Touget ned, saa at Draget blev horizontalt eller næsten horizontalt, og Skrabemunden ikke let løftedes fra Bunden. Under Skrabningen maatte man stadig have Opmærksomheden henvendt paa Accumulatoren. Dens Udvidelse og pludselige Sammentrækning igjen angav, naar Skraben tog Tag og atter slap Bunden, og selvfølgelig angav den ogsaa, naar Skraben satte sig fast. Naar Accumulatoren i dette Tilfælde havde udvidet sig saa meget, at man i den lave Stilling, som Loddeblokken indtog, ikke vilde have mere Kraft paa Touget, kommanderedes "Fir"! og Maskinisten ved Indhivningsmaskinen, som for dette Tilfældes Skyld altid stod klar, reverserede Maskinen og firede ud, paa samme Tid som Skibets Fart standsedes. I Regelen fik man Skraben løs ved at hive ind igjen paa Touget. Stod Accumulatoren stadig paa samme Mærke, antydede dette som oftest, at Farten var for stor, og at baade Vægt og Skrabe slæbtes gjennem Vandet fri af Bunden. For at have et Varsko, naar Accumulatoren pludselig udvidede sig over den tilbørlige Grændse, fastgjordes undertiden en Line med den ene Ende i Accumulatoren og med den anden i Damppiben, der saaledes peb, strax Accumulatoren blev for lang.

Skrabningen fortsattes ofte indtil et Par Timer, forend man begyndte *Indhivningen*. Under denne var Farten standset, og man lod Skibet drive tilbage. I Regelen foregik Indhivningen hurtigere end Skibet drev, saa at Touget viste klart ud i Læ. I modsat Fald gik man rundt med Fartøjet, lagde sig paa Læ Side af Touget og drev da tilsidst over Skraben.

Med fuld Fart paa Indhivningsmaskinen tog den ind 100 Favne i 6 à 7 Minutter. Var Skraben meget tung, maatte der hives langsommere. Eftersom Touget kom ind, haledes det fra Spillet over Hytten forefter og blev atter opskudt klart i Bingen forud. Dette var et meget anstrængende Arbejde, navnlig naar Indhivningen, som enkelte Gange Tilfældet, gik uden Stands i 4 til 5 Timer.

than the weight, it will fall vertically, with the heavy end foremost. If, on the other hand, its rate of descent be equal to or exceed that of the weights, it will, on reaching the bottom, have a horizontal component in its motion, — which is pretty sure to keep it from clogging during the ensuing operation.

So soon as the dredge, by our calculation, had reached the bottom, the rope was cast off forward, the bight brought aft, rove through the leading-block (a, Fig. 2) on the after part of the roundhouse, and then passed round the starboard drums, as shown in Fig. 1.

Steaming ahead at the rate of 1, $1^1/_2$, or 2 knots, on the same course as before, the dredge was pulled along the bottom, the tension of the motion of the vessel not however acting immediately upon it, but dragging forward the iron sinkers, which by their great weight serve to keep the direct traction horizontal, or nearly so, and thus prevent the mouth of the dredge from being readily lifted up. In dredging we had to keep our attention constantly fixed on the accumulator. Its extension and sudden contraction was a sure sign that the dredge was working properly, and of course the accumulator also told us when the dredge had fouled the bottom. A great and increasing strain upon the rope, pulling down the block and seriously stretching the accumulator, showed the dredge to have stuck fast, in which case we gave the word to veer, and an assistant engineer, who always stood ready for that purpose, reversed the donkey-engine and paid out the rope, the ship's way, too, being immediately deadened. By hauling in the rope we generally succeeded in extricating the dredge. Sometimes, the accumulator would remain stretched at the same point, and this we as a rule found to indicate that the speed of the vessel was too great, both weight and dredge being dragged through the water clear of the bottom. To give notice of any sudden stretching of the accumulator beyond the safe limit of extension, we hit on the expedient of fastening one end of a line to the apparatus and the other to the steam-whistle, which in that case would sound on the elastic bands running out too far.

Dredging from the "Vöringen" was frequently carried on for a couple of hours before *hearing in*. During the latter operation the vessel drifted before the wind. The rope being in the majority of cases brought in at a rate exceeding the drift of the ship, pointed leeward. If not, we steamed the vessel round, to get the rope to windward and drift over the dredge.

Working at full speed, the donkey-engine brought in 100 fathoms of dredge-rope in 6 or 7 minutes. When the dredge had got a very heavy freight to bring up, we heaved at a slower rate. As the rope came in, we hauled it from the drum of the engine over the roof of the roundhouse, and thence forward into the locker, where it was again coiled ready for the next operation. This was very fatiguing work indeed, particularly when the engine, as was

Naar Lodderne kom op, haledes Bugten af Touget ind til Loddebroen, hvor Vægten blev afstukken. Et godt Mærke paa, at Skraben havde været i Bund, var det, naar Lodderne var overtrukne med Bundler. Naar Skraben kom op, ihukedes et Takkel fra Gaffelen, og med dette løftedes den ind over Agterdækket.

Bundskrabning med Otter-Trawl. Naar man havde faaet denne klar ud i Søen, saa at Otterne skar ud og Nettet slæbte klart efter, foregik Operationerne som med Skrabe. Apparatet var imidlertid vanskeligt at faa klart til Bunds. Det behøvede en større Hastighed under Skrabningen, tog ikke meget af Bunden med og kom ikke sjælden uklart op. Det brugtes derfor efterhaanden mindre og blev det sidste Aar ganske fortrængt af Bom-Trawlen.

Bundskrabning med Bom-Trawl. Fra Agterdækket løftedes Bom og Mejer ud over Rækken ved en Jolle fra Gaffelen. Denne Jolle var fastgjort med en Tærs til en Strop paa Midten af Bommen. Dette gjordes, medens Skibet havde fuld Fart forover. Naar Bommen var kommen i den rette Stilling udenfor Rækken, standsedes Maskinen, Nettet kastedes ud, og man rykkede Tærsen ud ved en deri fastgjort Stjert, hvorefter Udfiringen af Skrabetouget begyndte. De videre Manøvrer var de samme som med Skraben, kun maatte Farten under Skrabningen være mindre, for at Trawlen skulde holde sig i Bund. En større Fart antoges at være hensigtsmæssig til at fange Fiske og anvendtes oftere en kortere Tid efter den egentlige Bundskrabnings Afslutning.

Naar Bomtrawlen kom op fuld af Bundler i hele sin nedre Del, maatte særegne Foranstaltninger til for at faa den ind paa Dækket, dels paa Grund af dens Længde dels paa Grund af dens Vægt, der var for stor til at dens nedre Ende kunde løftes ind med Haandmagt. Den fyldte Trawl havde Form af en Tragt, hvis Spids var udvidet til en Kugle af en Meters (3 Fods) Diameter. I dette Tilfælde sloges Stropper om selve Trawlnettet saa langt nede som muligt, og i disse hukedes Talje fra Gaffelen. Naar Trawlen med denne var løftet saavidt, at kun den nederste kugleformede Del var i Vandet, firedes ned under denne en "Indretning", bestaaende af en tyk Jernring, indvendig udføret med et meget stærkt Tougnet og som hang i 3 Ender, i hvilke man halede ombord under Indløftningen. Denne Sikkerhedsindretning, hvis Hensigt nærmest var at forhindre, at Trawlnettets nedre Ende skulde revne, naar den kom ud af Vandet, idet den bar en Del af Trawlnettets Vægt, var til stor Betryggelse og Hjælp ved at faa Trawlen ombord. Det hændte os ikke nogen Gang, at Trawlen aabnede sig selv under Indholdets Tryk; men før Indretningen kom i Brug, vovede vi ikke at hale Trawlen ombord, førend en stor Del af det fine Bundslam var udslemmet ved Trawlens Svingninger i Vandet.

often the case, had to be kept going for 4 or 5 hours at a stretch.

On the weights coming up, the bight of the rope was hauled in to the sounding-bridge, where they were severally detached. If covered with clay, it was a sure sign that the dredge had been at the bottom. When the dredge appeared, we hooked a tackle on to it from the gaff, by means of which the apparatus was got in on the after-deck.

Working the Otter-Trawl. — Once properly in the water, with the "otters" sheering out to either side, and the bag behind horizontally extended as the instrument was pulled along after the vessel, we worked the otter-trawl precisely as the dredge. The apparatus was, however, apt to foul before reaching the bottom, greater speed being requisite to work it; besides, it failed to secure a satisfactory sample of the bottom, and came up frequently foul. Hence, on discovering these drawbacks, we came to use it less; and on the last cruise it was entirely superseded by the beam-trawl.

Working the Beam-Trawl. — The beam and runners were hoisted over the railing of the after-deck by means of a whip from the gaff, secured with a toggle to a strap on the middle of the beam, — the vessel steaming ahead the while at full speed. So soon as the beam had been given the right position for letting go, the engine was stopped, the bag pitched out, and the toggle pulled off the strap by means of a lanyard, to which it was attached. This done, we began veering the rope. The remainder of the operation was the same as with the dredge, saving the speed, which we had to reduce lest the trawl should be lifted off the bottom. For catching fish, some increase in speed was presumed to be of advantage, and frequently tried as a wind-up to the bottom-trawling.

If the beam-trawl came up with the whole of the lower part filled with clay, special provision had to be made for getting it in, partly on account of its length, and partly owing to its great weight, which would not admit of lifting in the lower part by hand. With the bag full of clay or mud, the trawl had the shape of a cone, expanded at the apex into a sphere, 3 feet in diameter. A bight of rope was passed round the trawl-net as low down as possible, and a purchase hooked on from the gaff. Then, after hauling up the apparatus till the only part left in the water was the spherical extremity of the bag, we lowered under the latter a contrivance consisting of a thick iron ring, having the opening covered with strong cord netting, and the shank firmly secured to 3 stout hempen ropes, by which the apparatus was lifted over. This precautionary device, the main object of which was to prevent the trawl-bag, on its leaving the water, from bursting at the bottom while partially supporting the net and its contents, proved a safe and most efficient expedient for getting the instrument on board. On no single occasion did the bag give way from the pressure of its freight, whereas previous to our adoption of the contrivance, we had never dared to haul in the apparatus till

I Begyndelsen fulgte vi den efter "Challenger"-Expeditionen givne Anvisning med Hensyn til Manovren, at sejle ud den hele Touglængde i Læ og lade Skraben trækkes af Skibet, eftersom dette drev for Vinden. Det er ogsaa rimeligt, at denne Maade maa benyttes, naar Skrabningen skal udføres fra store og fuldkrafts Skibe, som ikke kan gaa saa langsomt for Maskinen, som Skrabningen fordrer. Dersom der Intet kommer ivejen, er det forsaavidt ligegyldigt, hvilken Vej man vælger, men i modsat Fald taber man meget baade i Tid og Arbejde. Naar man skraber under Gang mod Vinden, kan man regulere Farten efter Ønske og standse en Stund, hvis man frygter for at Farten har løftet Skraben fra Bunden. Driver man i Læ af Skraben, bestemmes Farten af Vind og Strøm, og tror man, det gaar for hurtigt, maa man fire ud Toug til Overflod, hvilket senere atter skal hales ind. Sætter Skraben sig fast, og man er til Luvart, behøver man ikke at fire mere end nogle faa Favne, indtil Farten er standset, og kan derefter strax begynde at hive ind, eftersom Skibet driver ned mod Skraben. Er man derimod i Læ, maa der fires ud en Mængde Toug, før man kommer paa Kurs og kan begynde at gaa op mod Skraben.

At faa Skraben los igjen, naar den har sat sig fast, kræver ofte en besværlig og langvarig Manover, der desuden ikke altid lykkes. Man maa hive ind til næsten op og ned og derefter søge at trække den los den modsatte Vej af den, man skrabede, da den gik sig fast. Da ukjendt Strøm ofte kan være tilstede, nødes man gjerne til at gjøre mange Forsøg. Lykkes disse ikke, staar det sidste Middel tilbage, at kaste Touget til en Pullert, gaa forover i Maskinen med fuld Kraft og enten rykke Skraben los eller sprænge Touget.

Det første Aar forsøgte vi et Par Gange at fæste Otter-Trawlen efter Skraben, men dette viste sig ikke videre hensigtsmæssigt. Naar man skraber, er Farten saa langsom, at Otter-Trawlen slæber langs Bunden som en Bundt Linegods, og sætter man Fart paa, saa at Otterne kan skjære ud til Siderne og holde Trawlmundingen aaben, løfter Skraben sig fra Bunden og gaar med sine paahængte Svabere et kort Stykke foran Trawlaabningen. Den vil saaledes rimeligvis bortskræmme den Fisk, der muligens ellers kunde være fangen.

Paa Expeditionens Rejser faldt der naturligvis adskillige mislykkede Kast med Skrabe og Trawl. Det hændte, at Apparatet ikke kom i Bund, at det blev iturevet i Bunden eller satte sig fast, at Skrabetouget sprang under Ind-

a considerable portion of the finest mud had been washed out, by allowing the trawl-bag to swing backwards and forwards in the water.

Dredging from the "Vöringen" was carried on at first in the way adopted on the "Challenger" Expedition — viz. by paying out to leward the due amount of rope, the dredge being then pulled along by the drift of the vessel. This is perhaps the only feasible method in dredging or trawling from large ships of full power, which cannot reduce their speed to the rate required for such operations. True, if all goes well, it is upon the whole immaterial which way is selected; but should, on the other hand, a mishap occur, a serious loss af time and labour will inevitably result. Dredging head to wind, the speed of a steamer may be regulated at pleasure, and her way immediately deadened should there be reason to believe the dredge is off the bottom. When drifting to leeward of the dredge, the speed will be dependent on the wind and the force and direction of currents, and if too high, an extra amount of rope has to be veered, which, of course, must afterwards be hauled in again. Should the dredge foul with the ship to windward, only a few fathoms will have to be veered before stopping the engine, after which the heaving in may be at once commenced, keeping pace with the ship as she drifts down upon the dredge. On the other hand, the ship being to leeward, a very considerable quantity of rope will have to be veered before she can be brought head to wind and steam up to the dredge.

To extricate the dredge when jammed fast at the bottom, is frequently a very difficult matter, involving hours of unremitting exertion, not always accompanied by a successful result. The rope must be hove in till nearly right up and down, attempt being made to extricate the dredge by hauling in a direction contrary to that in which it was moving when the mishap occurred. Moreover, the action of unknown currents will, by complicating the expedients adopted, often protract this laborious work. Should each in turn fail, there is nothing for it but to make fast the rope to a bollard head, and then, steaming full speed ahead, either free the dredge by sheer force or break the rope.

On the first cruise of the Expedition, by way of experiment, we sometimes made fast the otter-trawl behind the dredge, and worked both together; but this arrangement was not found to answer. With amply sufficient headway for dredging, the otter-trawl will drag along the bottom like a heap of cordage; and if, on the other hand, the speed be increased, to make the otters diverge and keep the mouth of the trawl open, the dredge, with its hempen tangles, will be lifted off the bottom and move along a short distance in front of the trawl-bag, scaring away probably many animals, in particular fishes, that might otherwise be captured.

Not every cast of the dredge and trawl was, of course, successful. Sometimes, the apparatus would fail to reach the bottom, or if there get broken, or jammed between rocks or stones; then again, we had the dredge-rope part.

hivningen, at Skrabeposen eller Trawlnettet lagde sig foran Aabningen og tilstoppede denne. Det første Aar brugtes mest Skrabe, hvortil tildels det uheldige Vejr var Grunden, enkelte Gange Ottertrawl og sjælden Bomtrawl. Det andet Aar kom Bomtrawlen i Brug ved Siden af Skrabe, medens Ottertrawlen heller ikke sjælden benyttedes. Det tredje Aar var Bomtrawlen vort Hovedapparat, som da var forsynet med alle de ovenfor nævnte Forbedringer, og brugtes overalt, selv paa de største Dybder, hvor Bunden var jevn og blød. Paa ujevn og haard Bund fik Skraben sin Anvendelse, hvorimod Ottertrawlen ikke blev benyttet.

Naar Skraben eller Trawlen var kommet ombord, begyndte Zoologernes og deres Assistenters Arbejde. Før Apparaterne kom ombord, fyldtes to store Baljer agterud med Søvand ved Hjelp af Donkeyen (en Hjælpepumpe i Maskinen). Til Sigtning af det optagne Bundmaterial brugtes et Sæt runde Sigter, hvert bestaaende af 3 saadanne, den ene staaende inde i den anden. Den underste Sigt havde en Diameter af $0.^{m}365$ (1 Fod 2 Tom.), den mellemste af $0.^{m}33$ (1 Fod 1 Tom.) og den øverste af $0.^{m}284$ (11 Tom.) Paa alle 3 var Kantens Højde $0.^{m}087$ ($3^1/_3$ Tom.) Maskerne var dannede af Kobbertraade og Aabningen mellem dem var paa den nederste Sigt $0.^{mm}3$ til $0.^{mm}5$, paa den mellemste $1.^{mm}5$ og paa den øverste $2.^{mm}$ (1 Linie). Sigterne var forsynede med opstaaende Haandtag paa begge Sider.

Naar Skraben kom ombord, afkappedes først Svaberne og derefter blev den firet ned paa Dækket. Sømmen i Sækken blev opsprættet paa begge Sider, og den løsnedes ligeledes fra Jernrammen paa den Side, som laa op. Sækkens Overdel toges af, og Indholdet laa afdækket klart til at tages under Behandling. Fiske, Stene og større Gjenstande udtoges strax til Opbevaring og nærmere Bestemmelse. Med en Øse, hvis Bund var af Metalnet, toges af Assistenterne en Portion af Bundmaterialet op i den øverste af et Sæt Sigter. Dette sænkedes ned i Vandet i en af Baljerne, Sigterne bevægedes op og ned, frem og tilbage, indtil det fine Slam var udslemmet, hvorpaa alle Sigters Indhold undersøgtes af samtlige Zookoger. Naar Skrabesækkens hele Indhold paa denne Maade var undersøgt, skylledes Sækken ren med en Vandstraale fra Donkeyen og gjordes klar til senere Brug. Svabernes Indhold udtoges af Zoologerne, et Arbejde, hvortil der i de fleste Tilfælde maatte benyttes Sax. Af saadanne havdes et større Antal i Reserve.

Trawlens Indhold af Bundmateriale tomtes paa Dækket derved, at man løste op Sammensnøringen i Enden af Bunden.

Den Tid, som en Bundskrabning tager, er væsentlig afhængig af Dybden, foruden naturligvis af den Tid, hvori den egentlige Bundskrabning foregaar. En Statistik herover,

when heaving in the gear, and the bag of the dredge or trawl was apt at times to twist round and clog the mouth of the instrument. On the first cruise, in 1876, partly because of the boisterous weather, we made chief use of the dredge, working the otter-trawl occasionally; the beam-trawl was seldom sent down. On the second cruise, both the beam-trawl and the dredge were in constant use, and we also worked the otter-trawl with comparative frequence. On the third and last cruise, the beam-trawl, with the various modifications before described, had come to be our principal apparatus; indeed, we used it exclusively in every locality, even at the greatest depths, on a smooth and soft bottom. Where the bottom was hard and rugged, we had recourse to the dredge. Of the otter-trawl, no use whatever was made in 1878.

So soon as the dredge or trawl was hauled on deck, our naturalists and their assistants set to work Shortly before the apparatus was got in, two large tubs on the the after-deck were filled with sea-water by means of the steam-pump. For sifting the contents of the bag, we had a set of 3 sieves, fitting freely one within the other The third or bottom sieve had a diameter of 1 foot 2 inches; the second of 1 foot 1 inch; and the first of 11 inches. The depth was the same in each — $3^1/_3$ inches. These sieves were made of copper wire, the bottom sieve with 0.02 inch meshes, the second with 0.075 inch meshes, and the first with 0.1 inch meshes. Each sieve was provided with a pair of vertical iron handles.

Having hauled the dredge over the railing, the first thing we did was to cut off the hempen tangles, and then lower the apparatus on deck. After ripping open the seam of the bag, the netting, on the side lying up, was detached from the frame, and the top part of the bag removed, thus exposing the contents. Fishes, stones, and all larger bodies were at once laid aside, to be stored for subsequent examination. With a ladle having the bottom of brass wire netting, the assistants transferred to the top sieve part of the sample of the bottom brought up in the apparatus. The set of sieves were then moved gently up and down — from side to side — in one of the tubs of water, till the fine mud or ooze had passed through each, after which the three naturalists carefully examined the sieves in succession. When the whole contents of the dredge or trawl had been sifted and examined, the bag of the apparatus was thoroughly rinsed, by directing on to it a jet of water from the steam-pump, and then put by ready for use. The delicate organisms brought up on the hempen tangles had mostly to be clipped out with short scissors, of which there was an ample supply.

For emptying the trawl, we had a contrivance by means of which the bottom of the bag was made to unlace, and the contents could thus be deposited on deck without inverting the apparatus.

The time occupied in a dredging is mainly dependent on the depth, but of course to a considerable extent also on the length of the interval devoted to working the in-

udregnet af Skibsjournalens Opgaver over Klokkeslettet, da Skrabe (Trawl) blev sat ud, da Lodderne blev slupne, da man begyndte Bundskrabningen, da den endte, og Indhivningen begyndte, og da Skraben (Trawlen) kom op igjen, viser, at en Skrabning paa 100 Favnes Dyb gjennemsnitlig tog $1^1/_2$ Time, paa 500 Favnes Dyb $4^1/_4$ Time, paa 1000 Favnes Dyb $7^1/_3$ Time, paa 1500 Favnes Dyb $10^1/_2$ Time. Eller, udtrykt ved en Tilnærmelsesformel, kan man sige, at Tiden for en Bundskrabning =

$$1.5 + (\text{Dybden} - 100 \text{ Fv.})\ 0.654 \text{ Timer.}$$

Denne Formel giver for en Dybde af 2000 Favne en Tid af 14 Timer. Forresten kunde Tiden for en Bundskrabning paa en vis Dybde være temmelig forskjellig, eftersom Manovren gik mere eller mindre heldig. Var Trawlen meget tung f. Ex., maatte der hives langsommere ind. I 1878, da Trawlen mest var i Brug, varede gjerne selve Skrabningen længere end tidligere (2 Timer mod $1^1/_2$ Time), og Trawlen var ofte meget tung. Det viser sig af vor Statistik ogsaa, at Varigheden af den hele Operation gjennemsnitlig i 1878 var større end i 1877.

Overfladenet. Foruden de ovenfor beskrevne Fangstredskaber brugtes ogsaa meget hyppigt af Prof. Sars et Overfladenet, som bestod af en omtrent 1 Meter (3 Fod) lang Pose af fin Kammerdug, spids i den ene Ende, og aaben i den anden, der var fæstet til en Ring af Messingtraad. Til denne blev fastgjort i Hanefod en smækker Line. Naar der ved Ankomsten til en Arbejdsstation blev kommanderet "Sagte", udkastedes Nettet, og det slæbte efter Skibet under den aftagende Fart. Undertiden blev det ogsaa blot kastet ud fra Fartøjet under Stilleliggen og strax indhalet.

strument when down. Reference to the ship's logbook, in which were recorded the details of every operation, comprising the moment at which the dredge (or trawl) was put over, that at which the sinkers were let go, the actual dredging was commenced and terminated, when the heaving in began, and when the apparatus was hauled on deck, — shows the average time to have been as follows: — At a depth of 100 fathoms, 1 hour 30 min.; at a depth of 500 fathoms, 4 hours 30 min.; at a depth of 1000 fathoms, 7 hours 20 min.; and at a depth of 1500 fathoms, 10 hours 30 min. Or, expressed by an approximate formula, the time required for a dredging =

$$1.5 + (\text{the depth} - 100 \text{ fathoms})\ 0.654 \text{ hours.}$$

For 2000 fathoms, this formula will give 14 hours. Meanwhile, the time a dredging would occupy at any given depth, was found to vary not a little according to the greater or less success attending the operation. And moreover, if the trawl had got an exceptionally heavy freight, the rate of heaving in had to be reduced. In 1878, when chief use was made of the beam-trawl, we as a rule kept the apparatus longer at the bottom than on the two preceding cruises, and it often came up very heavy. It appears, too, from the entries in the log-book, that the average duration of a cast of the trawl in 1878 was greater than in 1877.

The Tow-Net. — Among the apparatus for prosecuting zoological work was a tow- or surface-net, of which Professor Sars made frequent use. It consisted of a conical muslin bag, 3 feet deep, attached to a stout brass ring, which, by means of a crow-foot, was made fast to a line of suitable thickness. Shortly before our arrival at an observing-station, after the ship's way had been deadened, Professor Sars cast out the tow-net, which was pulled along after the vessel till she stopped. Sometimes, he merely threw it over and hauled it in when there was no way on the ship.

Navigering.

Til Expeditionen var anskaffet et Admiralitets-*Kompas* fra England. Dets Plads var, som tidligere anført, strax forenfor Bestiklugaret paa Hytten (Fig. 2 c). Dets *Deviation* bestemtes ved Svingning af Skibet, i 1876 i Husø, i 1877 i Husø, ved Røst og i Vestfjorden, i 1878 i Bergen, paa Kysten af Øst-Finmarken nær Vardø, udenfor Sørøen ved Hammerfest, paa Ishavet vestenfor Beeren Eiland, under Beeren Eiland, under Spidsbergens Sydkap, under Grønlandsisen paa $76^1/_2$ Grads Bredde. Observationerne blev beregnede efter Archibald Smiths Methode strax efter, at de var tagne, og Resultaterne anvendte til Bestemmelse af Kursen. De benyttede Værdier af Misvisningen toges af de norske, britiske og danske Søkarter, naar Misvisningen ikke var bestemt ved vore egne Observationer.

Navigating the Ship.

An Admiralty-compass had been procured from England for the Expedition. Its place, as previously stated, was just forward of the chart-room on the roundhouse. The deviation of the instrument we determined by swinging the ship, — in 1876 at Huso; in 1877 at Husø, at Røst, and in the Vestfjord; in 1878 at Bergen, off the coast of East Finmark (near Vardø), off Sørøen (near Hammerfest), in the Arctic Ocean (west of Beeren Eiland), off South Cape, Spitzbergen, and off the Greenland ice-barrier, in lat. 76° 30′ N. Immediately on being taken, the observations were computed by Archibald Smith's method, and the results employed for shaping the ship's course. The variation was taken from the Norwegian, British, or Danish charts, when not previously determined by our own observations.

I 1876 anvendtes, foruden den almindelige *Log* med Flyndre og Line, ogsaa Masseys Patentlog. Denne viste sig ikke synderlig hensigtsmæssig paa Grund af de hyppige Standsninger, og et Par Exemplarer gik i Skruen og tabtes. Der savnedes ogsaa god Lejlighed til at kontrollere dens Nøjagtighed. I 1877 indsattes den af Premierlieutenant *M. Petersen* arrangerede *Vandlog*, hvis Anordning

On the first cruise, in 1876, we used Massey's patent log, as well as the common log with logchips and line. The first instrument, however, did not answer well, owing to the frequent stoppages; and on one or two occasions it fouled the screw, and was lost. Moreover, we had no good opportunity whereby to test its accuracy. In 1877, the "Vøringen" was furnished with a *water-log*, the inven-

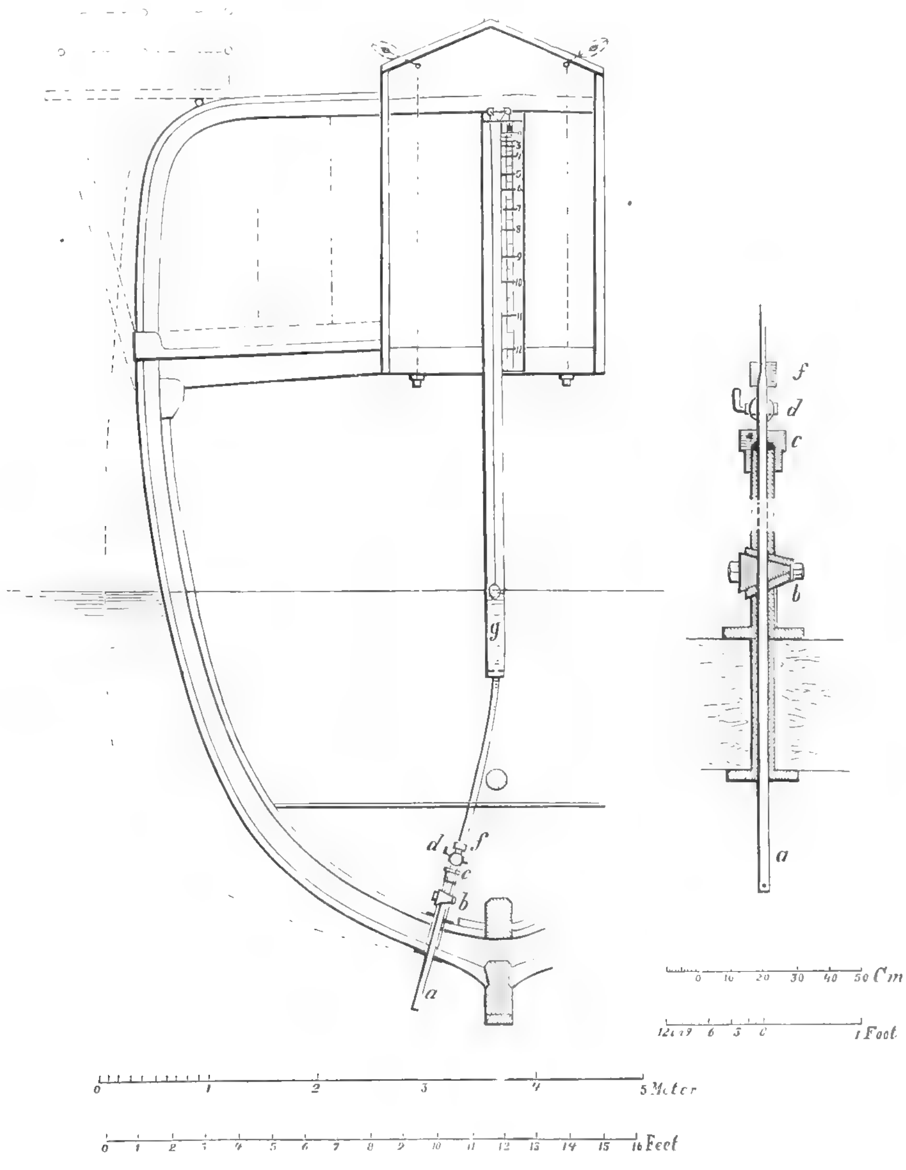

Fig. 21.

ombord i "Vøringen" sees af Fig. 21, der viser et Tversnit af "Vøringen" gjennem den agterste Del af Maskinrummet, seet forfra agterover. Vandloggen har følgende Indretning.

Paa et bekvemt Sted i Maskinrummet bores et Hul i Skibsbunden og føres med et 1 Toms Rør. Over dette anbringes med Flens Røret *b* (se den lille Figur) saaledes, at Aabningen i dette danner en Fortsættelse af Hullet i Bunden. Paa Midten af dette Rør er en konisk Kran og omkring dets øvre Ende er Skruegjænger til Pakningsringen *c*. Gjennem Røret *b* og Hullet i Skibsbunden nedsættes Røret *a* saa langt, at den lille Aabning i dets nedre Ende,

tion of Lieutenant *M. Petersen*. Fig. 21, representing a transverse section of the after part of the engine-room, as seen looking aft, shows the arrangement of the water-log on board.

In some convenient spot in the engine-room, a hole was bored in the ship's bottom to receive a one-inch metal tube, having fixed on to its top end the flange of the tube *b* (see small Figure), in such manner that the bore of the latter would form a continuation of the hole in the ship's bottom. This tube had a conical stop-cock, and its upper extremity screw-threads fitting into the gland *c*. The tube *a* was passed through the tube *b* and the hole in the ship's

der forøvrigt er lukket, kommer omtrent 0.m5 (20 Tommer) under Skibsbunden og visende ret forefter. Denne Afstand fandt vi var den hensigtsmæssigste. En mindre Afstand bragte Hullet for nær det af Skibsbunden medslæbte Vand, en større Afstand rønnede for meget paa det fritstaaende Ror under større Fart. Pakningsskruen c tilskrues. Ovenfor c bor Røret a have en mindre Kran d. Fra a's øvre Ende gaar et tyndt Blyrør til Stigerøret g, der har omtrent 10cm (4 Tommers) Diameter. Dette maa placeres midtskibs, vertikalt og saa lavt, at dets nedre Ende er godt under laveste (nederste) Vandlinies Plan. Det er forsynet med Blænde, for at ikke Vandet under Skibets Bevægelse skal pumpe i Røret. I dette Stigerør er anbragt en Flyder, fra hvilken der gaar en Snor over en Metalrulle paa Toppen af Røret, derfra over en anden Rulle paa Toppen af Skalaen, og Tampen er stukket gjennem et lidet Blylod, der vandrer mellem to tynde Messingstænger langs Skalaen, og som fæstes til Snoren ved at man trykker ind en liden Trækile nedenfra i det Hul, gjennem hvilket Snoren er trukket.

Under Skibets Fart forover trykkes Vandet op i Stigerøret, og eftersom Flyderen kommer højere, synker Loddet langs Skalaen. Saasnart Farten er bleven jevn, staar Loddet uforandret paa samme Højde paa Skalaen, hvor Fartens Størrelse da kan aflæses i et Øjeblik.

Vandloggen er, som man ser, en speciel Anvendelse af *Pitot*'s *Rør*. Kaldes den Højde, hvortil Vandet stiger i Stigerøret over det Niveau, det indtager, naar Fartøjet ligger stille, h, Skibets Hastighed v, Tyngdens Acceleration g og er M en Coefficient, saa har man[1]

$$h = M \frac{v^2}{2g}$$

Coefficienten M har efter Dubuats Forsøg en Værdi, der er større end 1, men bliver mindre, naar Hastighederne bliver større, uden dog at naa Enheden. Ved en Hastighed af 1.m8 pr. Sekund fandtes $M = 1.08$.

Ved Vandloggen, saaledes som den er indrettet af Lieutenant Petersen, er Coefficienten M sat lig 1. Rigtigheden eller Tilstrækkeligheden af denne Antagelse til ethvert praktisk Brug tilsøs, selv paa lange Rejser, er godtgjort ved den Anvendelse, Apparatet har havt paa "Vøringen" under 1877 og 1878 Aars Expeditioner og under dens Gang i Fragtfart paa Østersøen og Spanien, hvor lange Strækninger er udsejlede uden Afbrydelse. Endvidere har det samme Resultat vist sig af Vandloggens Anvendelse paa Oplodningsdampskibet "Hansteen" hvert Aar siden 1875 og paa Korvetten "Nornen" paa et Togt til Vestindien.

[1] Bresse, Cours de mécanique appliquée. Seconde partie, p. 335.

bottom, till the small aperture at its lower end, which for the rest was closed up, had been made to project about 20 inches beneath the bottom of the vessel, while pointing straight forward. This we found, by repeated experiment, to be the right distance. If diminished, it would bring the aperture too near the water carried along by adhesion to the ship's bottom; and if increased, it would, with greater speed, expose the projecting tube to a serious strain. The gland c has now to be screwed on. A little above the gland, the tube a should have a smaller stopcock d. From the top of a a slender leaden pipe led to the upper tube g, which had a diameter of nearly 4 inches. This tube must be given a vertical position amidships, and far enough down to bring its lower extremity well below the level of the lowest load water-line. It was provided with a blind, to prevent the water from pumping in the tube by reason of the motion of the vessel. In this upper tube there was a float, from which a line passed first over a brass roller at the top of the tube and then over another at the top of a graduated scale, the end of the line being rove through a small leaden weight that played against the scale between two slender brass rods, and was made fast to the line by inserting from below a small wooden wedge into the opening through which the former passed.

Now, on the ship moving ahead, the water will be forced into the upper tube and the weight descend along the scale as the float rises. So soon as the speed has become uniform, the weight will keep stationary, at the same point on the scale, and the rate may then be read off at a glance.

The water-log is obviously a special adaptation of *Pitot's tube*. Let h be the height to which the water in the upper tube rises above its level when the ship is stationary; v the speed of the vessel; g the acceleration of gravity; and M a coefficient, — we shall then have the formula[1]

$$h = M \frac{v^2}{2g}$$

The coefficient M has, according to Dubuat, a value greater than 1, which decreases however with the increasing velocities, though without reaching unity. For a velocity of 1.8m pr. second, the value of M was found to be 1.08.

For the water-log on Lieutenant Petersen's construction, the coefficient M is put equal to 1. And this is practically correct, even for comparatively long voyages, as shown from experience derived on the cruises of the "Vøringen" in 1877 and 1878, and on her voyages in the freight-trade to the Baltic and to Spain, very considerable distances having then been run at a stretch. Equally favourable results have been obtained, too, by the use of the water-log (since 1875) on board the Coast Survey steamer "Hansteen," and on a cruise of the steam-corvette "Nornen" to the West Indies. Now, supposing the coef-

[1] Bresse, Cours de mécanique appliquée. Seconde partie, p. 335.

Sættes Coefficienten M lig 1, Kvartmilen lig $^1/_{60}$ af en Ækvatorsgrad og g lig $9.^m810$ (50° N. Br.), saa faar man den følgende Tabel for Skalaens Inddeling.

ficient M to equal 1, a mile to equal $^1/_{60}$ of an equatorial degree, and g to equal 9.810^m (in lat. 50° N.), we have the following series of figures for graduating the scale.

Fart. (Speed.)	Skala. (Scale.)			Fart. (Speed.)	Skala. (Scale.)		
Kvartmil i Timen. (Miles an Hour.)	Meter. (Metres.)	Norske Fod. (Norw. Feet.)	Eng. Fod. (Eng. Feet.)	Kvartmil i Timen. (Miles an Hour.)	Meter. (Metres.)	Norske Fod. (Norw. Feet.)	Eng. Fod. (Eng. Feet.)
1	0.014	0.043	0.044	7	0.663	2.114	2.176
2	0.054	0.172	0.178	7.5	0.761	2.427	2.498
2.5	0.085	0.270	0.278	8	0.866	2.761	2.842
3	0.122	0.388	0.400	8.5	0.978	3.117	3.209
3.5	0.166	0.529	0.544	9	1.096	3.495	3.597
4	0.217	0.690	0.711	9.5	1.222	3.894	4.008
4.5	0.274	0.874	0.899	10	1.354	4.314	4.441
5	0.338	1.079	1.110	10.5	1.492	4.756	4.896
5.5	0.410	1.305	1.343	11	1.638	5.220	5.373
6	0.487	1.553	1.599	11.5	1.790	5.706	5.873
6.5	0.572	1.823	1.876	12[1]	1.949	6.213	6.395

Vil man efterse, om Røret gjennem Bunden er i Orden, stænges Kranen d, Pakningsstykket f afskrues, og Blyrøret bøjes noget til Side; man løsner paa Pakningsringen c, Røret a løftes op, indtil dets nedre Ende har passeret Kranen paa Røret b, hvorefter denne afstænges, og Røret a kan løftes helt op og eftersees.

Ved Brugen af Vandloggen maa to Ting haves i Erindring:

1) at Skalaens Nulpunkt eller rettere Snorens Længde fra Flyderen til Vægten, der tjener til Viser paa Skalaen, retter sig efter Skibets Dybgaaende, og

2) Fejlen, der foraarsages ved stadig Krængning.

Med Hensyn til det første Punkt, reguleres dette lettest derved, at man standser Skibets Fart, udtager Trækilen og flytter Loddet paa Nul. Det hele kan udføres i nogle Minutter. Ved de hyppige Stopninger, som Lodning og Skrabning foranledigede, kunde vi paa Nordhavs-Expeditionen altid holde Vandloggen skarpt justeret. Paa Sejlskibe vil Forbruget ombord ikke saaledes forandre Dybgaaendet, som paa Dampskibe, men man bør dog imellem foretage et Par nøjagtige Logninger med den almindelige Log og Uhr, for at kontrollere Vandloggen og eventuelt justere den paany.

To ascertain whether the tube passing through the ship's bottom be in order, the stopcock d is turned back, the gland f screwed off, and the leaden tube bent a little aside; then, after partially unscrewing the gland c, the tube a is lifted up till its lower extremity is just clear of the cock of the tube b, and when this too has been turned back, the tube a may be taken out and examined.

When using the water-log, two things must be borne in mind, viz. —

1) That the position of zero on the graduated scale, or rather the length of the line from the float to the weight which plays against the scale, is regulated by the draught of the ship; and

2) The heeling error.

As regards the first source of error, the index is best regulated by stopping the vessel, and then, after taking out the wooden wedge, placing the weight at zero. This may be done in a few minutes. With the frequent stoppages involved in sounding and dredging on the North-Atlantic Expedition, we could always manage to keep the water-log accurately adjusted. In sailing-vessels the draught is not of course as in steamers affected by the consumption of coal; but now and then the speed should nevertheless be closely determined with the common log as a means of testing the results of the water-log, and, if necessary, of adjusting that instrument anew.

[1] Ved 80° Bredde med $g = 9.^m830$ bliver Skalastregen for 12 Miles Fart 1.945 Meter, altsaa kun 4^{mm} forskjellig fra Tabellens. For de mindre Hastigheder bliver Forskjellen forholdsvis mindre.

[1] In lat. 80° N., where $g = 9.830^m$, the division on the scale denoting a speed of 12 knots will correspond to 1.945^m, and thus exhibit a difference of only 4^{mm} as compared with the figures in the Table. For less velocities, the difference will be proportionally reduced.

Med Hensyn til det andet Punkt, Krængningsfejlen, da kommer denne i Betragtning kun ved større og stadig Krængning. Slingringernes Virkning er næsten ganske hævet ved Hullets Tranghed og Blænderen. Antages at Stigerøret staar midskibs og vertikalt, naar Skibet ligger paa ret Kjøl, og sættes den lodrette Afstand fra Havniveauet til det Punkt, om hvilket Fartøjet drejer sig, naar det begynder at krænge, lig x, regnet positiv fra Havniveauet nedad mod Kjølen, samt Krængningsvinkelen i og den under denne Krængning paa Skalaen aflæste Fart v', saa har man, idet de tidligere Benævnelser h og v beholdes:

$$v'^2 = 2g\left(\frac{h + x}{\cos i} - x\right) = \frac{2gh + 2gx}{\cos i} - 2gx = \frac{v^2 + 2gx\,(1 - \cos i)}{\cos i}$$

$$v^2 = v'^2 \cos i - 4gx \sin^2 \frac{i}{2}$$

x, v og v' maa regnes i samme Enhed (Meter, Fod), Tidsenhed er Sekundet. 1 Kvartmil i Timen svarer til 0.5153 Meter pr. Sekund.

Den følgende Tabel giver en Oversigt over Resultaterne efter denne Formel. Den er beregnet for en Krængning $i = 20°$, og efter Værdierne af $x = 0$, $x = +1^m$ og $x = -1^m$.[1]

[1] Værdien af x kan findes, naar man krænger Fartøjet, medens det ligger stille, og observerer Krængningsvinkelen i samt Længden o af det Stykke, Vandets Overflade har flyttet sig fra det oprindelige Niveau i Røret. Ligger Niveauet under Krængningen højere, det er over Nulpunktet (Loddet paa Tal paa Skalaen), er x positiv, ligger det lavere (Loddet ovenfor Nulpunktet paa Skalaen), er x negativ. Formelen er:

$$x = o\,\frac{\cos i}{2 \sin^2 \frac{i}{2}}$$

Ex. $i = 20°$, $o = 0.^m05$, $x = 0.^m779$.

Den negative Værdi af x lig en hel Meter er medtaget som Regneexempel for at vise Virkningen af en saadan, omendskjønt den ikke vil forekomme i Praxis.

The other source of error, viz. heeling, may be ignored altogether, save when the heeling is both great and continuous. The effect of rolling on the water-log will, as a rule, be almost wholly counteracted by the narrowness of the aperture of the tube, and by the blind. Supposing the upper tube, placed amidships, to have a vertical position when the ship is on an even keel, then, if x be the length of the perpendicular from the level of the sea to the point about which she turns on beginning to heel, — assumed positive from the level of the sea towards the keel, — i the heeling-angle, and v' the speed, as read off on the scale with the vessel at that angle, we have, h and v denoting as before, —

$$v'^2 = 2g\left(\frac{h + x}{\cos i} - x\right) = \frac{2gh + 2gx}{\cos i} - 2gx = \frac{v^2 + 2gx\,(1 - \cos i)}{\cos i}$$

$$v^2 = v'^2 \cos i - 4gx \sin^2 \frac{i}{2}$$

The value of x, v, and v' must be taken in the same unit of measure (metre, foot). The unit of time is a second. One mile an hour corresponds to 0.5153 metre pr. second.

The following Table gives the results obtained by this formula, taking 20° as the angle of heel, and with the values $x = 0$, $x = +1^m$, and $x = -1^m$.[1]

[1] The value of x may be found by heeling the ship when stationary, and then observing the angle of heel i, together with the distance o, through which the water in the tube has moved from its original level. If the level in heeling be higher, i. e. above zero (the weight within the divisions of the scale), the value of x will be positive; if lower (the weight above zero), x will be negative. The formula is as follows: —

$$x = o\,\frac{\cos i}{2 \sin^2 \frac{i}{2}}$$

Example: $i = 20°$, $o = 0.^m05$, $x = 0.^m779$.

The negative value of x put equal to a whole metre, is introduced merely by way of example, to show its *possible* effect, the case never occurring in practice.

Krængning 20°. · *Angle of Heel* 20°.

Observeret Fart. (*Observed Speed.*) Kvartmil i Timen. (*Miles an Hour.*)	Virkelig Fart. (*Actual Speed.*)			v Kvartmil i Timen. (*Miles an Hour.*)			
	$x = 0$			$x = +1^m$		$x = -1^m$	
v'	v	Corr. (*Corr.*)	Diff. f. 1 Kvartmil. (*Diff. for 1 Mile.*)	v	Corr.	v	Corr.
12.0	11.6	—0.4	0.03	11.4	—0.6	11.8	—0.2
9.0	8.7	—0.3	0.03	8.5	—0.5	9.0	0.0
6.0	5.8	— 0.2	0.03	5.4	—0.6	6.2	+0.2
4.0	3.9	—0.1	0.03	3.3	—0.7	4.4	+0.4
3.0	2.9	— 0.1	0.03	2.0	—1 0	3.6	+0 6
2.5	2.4	—0.1	0.03	1.2	—1.3	3.2	+0.7
2.2	2.1	—0.1	0.03	0.4	—1.8	3.0	+0.8
2.177	2.1	—0.1	0.03	0.0	—2.2	3.0	+0-8
1.0	1.0	0 0				2.3	+1.3

Man ser, at Krængningsfejlen, selv med en saa stor Krængning som 20°, for de større Farter kun udgjør Brøkdele af en Knobs Fart. Svinger Fartøjet om et Punkt i eller nær Vandliniens Flade, er Krængningsfejlene i ethvert Tilfælde meget smaa.

Anderledes stiller Forholdet sig, dersom Stigerøret ikke staar midtskibs. Der kommer da under Krængning en ny Korrektion til, som bliver positiv for Krængning til den ene Side og negativ for Krængning til den anden, og hvis Størrelse voxer med Stigerørets Afstand fra Diametralplanet.

Efter vor Erfaring viste Vandloggen sig særdeles hensigtsmæssig og holdtes med største Lethed i Orden. Et Blik ned i Maskinskylightet var nok til at observere Skibets Fart i Øjeblikket. Maskinisten kunde under Skrabning og Trawling holde Skibet gaaende med den befalede Fart. Til Reduktion af de observerede Vindretninger og Vindhastigheder til sande kræves Skibets Hastighed i Observationsøjeblikket. Denne observeredes paa Vandloggen, der saaledes er et udmærket nautisk-meteorologisk Apparat.

Astronomiske Observationer. Da Expeditionen færdedes paa høje nordlige Bredder om Sommeren, var der ikke Tale om at observere andre Himmellegemer end *Solen* til Bestemmelse af Skibets paaværende Plads. Observationerne gjordes med flere *Sextanter*, der altid var godt verificerede, og hvis Indexfejl stadig blev kontrolleret. Sammenlignende Observationer med forskjellige Sextanter gav altid godt overensstemmende Resultater. Observationspladsen var i Regelen Hyttedækket. I Solobservationernes Udførelse og Beregning deltog, foruden jeg selv og Skibsofficiererne Petersen og Grieg, Professor Mohn og Hr. Tornøe. Solhøjder maaltes til alle Dagstider, naar der var Anledning. I 1878 iagttoges oftere Midnatsolen. Det var kun yderst faa Dage, paa hvilke der manglede Observationer.

It is evident that, with greater speed, the error involved in heeling, even at an angle of 20°, will amount to only a fraction of a mile. And if the point about which the vessel turns lie in or near the plane of the water-line, the error will be generally very small.

The case, however, is different in the event of the upper tube not being amidships. Another correction, positive with a heel to the one side, negative with a heel to the other, will then be needed for computing the speed, and the effect of the heeling will increase with the distance of the upper tube from amidships.

So far as our experience went, we had every reason to be satisfied with the water-log; it answered excellently, and was easy to keep in order. A glance down the engine-room skylight sufficed to tell the ship's speed. Hence, in dredging or trawling the engineer could keep the vessel at the exact rate required. For reducing observations of the wind's direction and velocity to their true value, the speed of the vessel at the moment of observation has to be found. Now, this we took from the water-log, which accordingly proved an excellent instrument for meteorological work at sea.

Astronomical Observations. — The North-Atlantic Expedition having to cruise in high northern latitudes during the summer season, observations of other celestial bodies than the sun for determining the ship's position were of course out of the question. The altitudes were taken with several sextants, accurately verified; the index-error, too, being determined for each separate observation. The results of comparative observations with different sextants never failed to exhibit satisfactory agreement. Our post of observation was, as a rule, the roof of the roundhouse. Besides myself and the ship's officers, Mr. Petersen and Mr. Grieg, Professor Mohn and Mr. Tornøe also assisted in taking the observations and computing their results. Solar altitudes were taken at all hours of the day; nay, on the last cruise, in 1878, we

Kronometrene stod i et Skab i Arbejdssalonen om Bagbord (Fig. 4, c). De blev optrukne hver Morgen og derpaa indbyrdes sammenlignede.

I 1876 havdes 3 Kronometre ombord, et af Kullberg, et af Mewes og et af Frodsham. Det første, der ved den paa Bergens Observatorium af Hr. Astrand foretagne Undersøgelse før Rejsen viste den jevneste Gang, blev benyttet som Hoveduhr.

I 1877 og 1878 havdes 4 Kronometre ombord, nemlig foruden de 3 nævte. et af Reid, der var Skibet tilhørende. Dette Kronometer viste en saa fortræffelig jevn Gang, at det benyttedes som Hoveduhr de 2 sidste Aar.

Kronometrenes Stand blev bestemt, først paa Bergens Observatorium (undtagen Reid) og senere hovedsagelig ved de telegrafiske Tidssignaler fra Christiania. Disse Signaler gives fra Observatoriet i Christiania hver Onsdag Morgen Kl. 8 Formiddag og hver Søndag Morgen Kl. 9 Form., *Greenwich* Middeltid, til samtlige norske Telegrafstationer. Signalerne gives paa Observatoriet direkte efter Normalpendelen. Der telegraferes hver Gang 3 Signaler, hvert bestaaende af et enkelt Slag fra Nøglen paa Morses Telegrafapparat, nemlig $7^h\ 59^m\ 0^s$, $8^h\ 0^m\ 0^s$ og $8^h\ 1^m\ 0^s$ om Onsdagen og $8^h\ 59^m\ 0^s$, $9^h\ 0^m\ 0^s$ og $9^h\ 1^m\ 0^s$ om Søndagen. For at skille mellem Signalerne betegnes de henholdsvis med 1, 2 og 3 dobbelte Slag strax efter Signalet. Paa Modtagelsesstationen, hvor man indfinder sig med sit Kronometer eller Observationsuhr, høres Signalerne kort og skarpt paa Morses Apparat.

Ved 15 Par korresponderende Solhøjder paa Husø (4° 36′ 57″ øst f. Greenwich) fandt Prof. Mohn den 10de Juni 1876 Kronometret Kullberg $0^h\ 38^m\ 43.3^s$ foran Greenwich Middeltid.

Under Expeditionens Ophold i Reykjavik toges af Lieutn. Petersen og mig den 1ste August 1876 14 Par korresponderende Solhøjder paa en Plads, der ligger omtrent 200 Alen østenfor Kirken. Ifølge velvillig Meddelelse fra Chefen for det Kgl. Danske Søkaart-Archiv, Hr. Kommandør *Rothe*, er, ifølge saavel ældre som nyere Iagttagelser, Længden af et Punkt, der ligger 600 Alen vestenfor Kirken

21° 54′ 46″ W. Greenwich.

Vor Observationsplads ligger saaledes ca. 800 Alen øst for dette Punkt, hvilket, da Bredden er 64° 9′, svarer til 38″ i Længde, og Længden af vor Observationsplads bliver saaledes 21° 54′ 8″ W. Greenwich eller i Tid: $1^h\ 27^m\ 36.^s5$

Kronometrets Stand for Stedets Middeltid fandtes	$2^h\ 6^m\ 55.^s7$ foran
altsaa dets Stand for Greenwich Middeltid	$0^h\ 39^m\ 19.^s2$ foran

frequently observed the sun at midnight. The days on which no observations could be taken were very few indeed.

The *Chronometers* we kept in a cupboard in the workroom, on the port side (Fig. 4, c). They were wound up every morning, and duly compared.

On the first cruise, in 1876, we had 3 chronometers, — one by Kullberg, one by Mewes, and one by Frodsham That by Kullberg, which, previous to the departure of the Expedition, Mr. Astrand, Director of the Bergen Observatory, had found to have the most uniform rate of the three, was our principal timekeeper in 1876.

In 1877 and 1878 there was a fourth chronometer, one of Reid's, belonging to the ship. This instrument having a remarkably uniform rate, we made it our chief timekeeper on the two last cruises.

The error of each chronometer was first determined at the Bergen Observatory (saving that of the Reid), and afterwards chiefly by comparison with the time-signals telegraphed from Christiania. The observatory of that city transmits these signals every Wednesday morning at 8 a. m. and every Sunday morning at 9 a. m., *Greenwich* mean time, to all Norwegian telegraph-stations. The time is taken at the observatory direct from the standard-clock. Three separate time-signals, each consisting of a single click, are telegraphed, from the key of Morse's apparatus, at intervals of one minute, viz.: — Wednesdays, at $7^h\ 59^m\ 0^s$, $8^h\ 0^m\ 0^s$, and $8^h\ 1^m\ 0^s$; Sundays, at $8^h\ 59^m\ 0^s$, $9^h\ 0^m\ 0^s$, and $9^h\ 1^m\ 0^s$. To distinguish between the signals, they are respectively indicated by double clicks, 1, 2, and 3, following after the signal in the order of succession. At the receiving station, where the observer stands by with his chronometer or hack-watch in hand, the signals come sharp and distinct from Morse's apparatus.

From 15 pairs of equal solar altitudes, taken at Husø (long. 4° 36′ 57″ E.) on the 10th of June 1876, Professor Mohn found the error of Kullberg's chronometer, on Greenwich mean time, to be $0^h\ 38^m\ 43.^s3$ fast.

During the stay of the Expedition at Reykjavik, Lieutenant Petersen and myself took 14 pairs of equal solar altitudes, at a point about 140 yards east of the cathedral. From information kindly furnished by Commodore *Rothe*, Hydrographer to the Royal Danish Navy, it appears that the longitude of a point 410 yards west of the church, has been found, by earlier as well as recent observations, to be —

21° 54′ 46″ W.

Our post of observation was thus about 550 yards east of this point, which corresponds, the latitude being 64° 9′, to 38″ in longitude. Hence, our post of observation was in

Longitude 21° 54′ 8″ W., or in time	$1^h\ 27^m\ 36.^s5$
Error of chronometer on mean time of place	$2^h\ 6^m\ 55.^s7$ fast;
therefore on Greenwich mean time	$0^h\ 39^m\ 19.^s2$ fast.

I nedenstaaende Tabeller er givet en Oversigt over Hovedkronometrets Stand og Gang under vor Expedition.

1876. Kronometer Kullberg.

Dag.	Stand foran Gr. Middelt.	Daglig Acceleration.	Sted.
Mai 30	$0^h\ 38^m\ 37.^s8$	$0.^s66$	Bergens Observatorium.
Juni 10	38 43. 3	0. 50	Huso. Corr. Højder.
Juni 26	38 59. 6	1. 02	Kristiansund. Tel. Sig.
Aug. 1	39 19. 2	0. 54	Reykjavik. Corr. Højder.
Aug. 20	39 33. 6	0. 76	Namsos. Tel. Sig.

Sammenstilles de Værdier af Kronometrets Stand, som er benyttede ombord, med de som følger af Tabellens Tal ved ligefrem Interpolation, saa finder man, at den største Forskjel falder den 22de Juli, da den brugte Stand er $39^m\ 21^s$ og den efter Tabellen fundne $39^m\ 14^s$. Forskjellen er 7^s i Tid eller 1.′75 i Bue af Parallelgraden. Da Bredden her var mellem 63° og 64°, bliver Fejlen i Storcirkelbue 0.′78, en saa liden Størrelse, at vi i vore Opgaver over Skibets (Stationernes) paaværende Plads har beholdt de under Rejsen bestemte Værdier af Bredder og Længder. Den næststørste Afvigelse mellem den benyttede og beregnede Værdi af Kronometrets Stand findes den 13de August, da den er — 5^s, hvilket svarer til en Afstand af 0.6 Kvartmil.

1877. Kronometer Reid.

Dag.	Stand efter Gr. Middelt.	Daglig Retardation.	Sted.	
Maj 23	$0^h\ 7^m\ 23.^s0$	$0.^s90$	Bergen.	Tel. Sig.
Juni 24	7 54. 0	0. 97	Bodo.	do.
Juli 11	8 10. 0	0. 94	Tromso.	do.
Juli 22	8 21. 2	1. 02	Tromso.	do.
Aug. 12	8 39. 5	0. 86	Bodo.	do.

Ved Ankomsten til Bodø den 23de Juni var den beregnede Stand af Kronometret $7^m\ 51^s$, og den af Verifikationen den følgende Dag udledede $7^m\ 53^s$, altsaa en Forskjel af 2^s, der paa 67° Bredde svarer til en Afstand af 0.2 Kvartmil. Ved Tilbagekomsten fra Jan Mayen beregnedes Observationerne ombord den 9de August udenfor Lofoten med en Kronometerstand af $8^m\ 39^s$. Den efter Verifikationen i Bodo den 12te August bestemte Stand er $8^m\ 36.^s7$. Forskjellen, $2.^s3$, svarer til en Afstand af 0.2 Kvartmil

1878. Kronometer Reid.

Dag.	Stand efter Gr. Middelt.	Daglig Retardation.	Sted.	
Juni 23	$0^h\ 15^m\ 4.^s5$	$1.^s00$	Hammerfest.	Tel. Sig.
Juli 10	15 19. 0	0. 85	do.	do.
Juli 28	15 36. 5	0. 97	do.	do.
Aug. 28	16 6. 8	0. 98	Tromso.	do.

Dén 7de Juli, da sidste Observation toges Dagen for Tilbagekomsten til Hammerfest paa første Tur, regnedes

In the following Tables are set forth the error and rate of our chief chronometer.

1876. Kullberg's Chronometer.

Date.	Chron. Fast on G. M. T.	Gaining daily.	Place.
May 30	$0^h\ 38^m\ 37.^s8$	$0.^s66$	Bergen Observatory.
June 10	38 43. 3	0. 50	Huso. Equ. Altit.
June 26	38 59. 6	1. 02	Christiansund. Tel. Sig.
Aug. 1	39 19. 2	0. 54	Reykjavik. Equ. Altit.
Aug. 20	39 33. 6	0. 76	Namsos. Tel. Sig.

By comparing the assumed values of the error of the chronometer with those deduced, by simple interpolation, from the figures in the Table, the greatest difference is found to have occurred on the 22nd of July, the assumed error having been $39^m\ 21^s$ as against $39^m\ 14^s$, the error determined from the Table, — a difference of 7^s in time, or 1.′75 in arc of parallel of latitude. The latitude was between 63° and 64°, which reduces the error, in arc of great circle, to 0.′78, an error so small that we did not hesitate, when recording the position of the ship, to retain the latitudes and longitudes determined on the cruise. The next greatest difference between the observed and computed error occurred on the 13th of August: it was 5^s, which corresponds to 0.6 of a nautical mile.

1877. Reid's Chronometer.

Date.	Chron. Slow by G. M. T.	Losing daily.	Place.	
May 23	$0^h\ 7^m\ 23.^s0$	$0.^s90$	Bergen.	Tel. Sig.
June 24	7 54. 0	0. 97	Bodo.	do.
July 11	8 10. 0	0. 94	Tromso.	do.
July 22	8 21. 2	1. 02	Tromso.	do.
Aug. 12	8 39. 5	0. 86	Bodo.	do.

On our arrival at Bodo, June 23rd, the computed error of the chronometer was $7^m\ 51^s$, whereas the error found next day by verification amounted to $7^m\ 53^s$, making a difference of 2^s, which, on the 67th parallel of latitude, corresponds to a distance of 0.2 of a nautical mile. When returning from Jan Mayen, observations taken on the 9th of August, off Lofoten, were calculated with an assumed error of $8^m\ 39^s$. The error found by verification at Bodo on the 12th of August was $8^m\ 36.^s7$. The difference, $2.^s3$, corresponds to 0.2 of a nautical mile.

1878. Reid's Chronometer.

Date.	Chron. Slow by G. M. T.	Losing daily.	Place.	
June 23	$0^h\ 15^m\ 4.^s5$	$1.^s00$	Hammerfest.	Tel. Sig.
July 10	15 19. 0	0. 85	do.	do.
July 28	15 36. 5	0. 97	do.	do.
Aug. 28	16 6. 8	0. 98	Tromso	do.

For our last observation on the first cruise of the Expedition, taken July 7th, the day before returning to

ombord med Kronometerstanden 15^m 18.^{s}8. Efter Verifikationen den 10de i Hammerfest skulde Standen være 15^m 16.^{s}4. Forskjellen, 2.^{s}4 svarer, da Bredden var 72°, til en Afstand af 0.18 Kvartmil.

Den 24de Juli, da Expeditionen kom tilbage til Hammerfest fra den anden Tur, regnedes ombord med Kronometerstanden 15^m 31^s. Den efter Signalerne den 28de Juli korrigerede Stand er 15^m 32.^{s}6. Forskjellen, 1.^{s}6, svarer, da Bredden er 73°, til en Afstand af 0.12 Kvartmil.

Den 24de August, da sidste Observation toges paa Tilbagerejsen fra Spidsbergen til Tromsø, regnedes Standen af Kronometret ombord til 16^m 2.^{s}0. Efter Verifikationen den 28de i Tromsø skulde den være 16^m 3.^{s}0. Forskjellen, 1.^{s}0, svarer, da Bredden var 74½°, til en Afstand af 0.06 Kvartmil.

Tager man Hensyn til Usikkerheden af Størrelsen af Kimmingdalingen — vi regnede med en konstant Værdi for alle fra Hyttedækket tagne Solhøjder — der beror paa Horizontalrefraktionen, og til Virkningen af Irradiation til at gjøre den iagttagne Solradius mere eller mindre for stor, eftersom Solbilledet ses mere eller mindre lyst, kan vel den sandsynlige Fejl af en paa Søen maalt Solhøjde neppe sættes under $\pm$ 1′. Da i Regelen nedre Solrand maaltes, gjør Irradiationen de maalte Højder for smaa, Bredderne for store ved Middag, for smaa ved Midnat, Timevinklerne for store paa Vestsiden, for smaa paa Østsiden, østlige Længder for store paa Vestsiden, for smaa paa Østsiden, vestlige Længder for smaa paa Vestsiden, for store af Observationer paa Østsiden.

Saa ofte Anledning gaves, og det paa ganske faa Undtagelser nær i Regelen hver Dag, og særlig ved Ankomsten til en Arbejdsstation, korrigeredes Bestikket ved Observationerne. Disse beregnedes altid (undtagen Meridianhøjder) med 2 vilkaarlige Bredder eller, naar de var nær Meridianen, med 2 vilkaarlige Længder. Nautical Almanacs Tabeller benyttedes. Stedlinien blev afsat i Kartet som en ret Linie mellem de 2 saaledes bestemte Punkter. Ved Hjælp af den imellem 2 Observationer udsejlede Kurs og Distance bestemtes den paaværende Plads i hver af Stedlinierne. Stationernes Bredde og Længde bestemtes saaledes af mig og indførtes i Loddejournalen. Bestik og Observationer svarede i Regelen meget godt. Under Skrabning og Trawling blev vi imidlertid altid sat ud af Bestik, da det var vanskeligt at holde Rede paa Kurser og udløbne Distancer under disse Manøvrer.

Efter det ovenfor anførte om vore Kronometres Gang og om den sandsynlige Fejl af en maalt Solhøjde fremgaar det, at vore Værdier for Stationernes Bredde og Længde har en sandsynlig Fejl af mellem 1 og 2 Minuter. For den største Dels Vedkommende overstiger Fejlen ikke synderlig 1 Minut.

Hammerfest, we assumed the error of the chronometer to be 15^m 18.^{s}8. From the verification at Hammerfest on the 10th, it was found to have been 15^m 16.^{s}4. The difference, 2.^{s}4, corresponds on the 72nd parallel of latitude to 0.18 of a nautical mile.

When returning to Hammerfest on the second cruise, we assumed the error of the chronometer for an observation taken July 24th to be 15^m 31^s. Corrected at Hammerfest on the 28th by comparison with the time-signals, it proved to have been 15^m 32.^{s}6. The difference, 1.^{s}6, corresponds, in latitude 73°, to 0.12 of a nautical mile.

On the 24th of August, when returning from Spitzbergen to Tromsø, we assumed the error of the chronometer to be 16^m 2.^{s}0. Verified at Tromsø on the 28th, it was found to have been 16^m 3.^{s}0. The difference, 1.^{s}0, corresponds, in latitude 74° 30′, to 0.06 of a nautical mile.

If we consider the difficulty of determining the dip of the horizon, — a constant value was assumed for all solar altitudes taken from the roof of the roundhouse, — depending as it does on horizontal refraction, and also take into account the effect of irradiation in magnifying to a greater or less extent the diameter of the sun, according as the solar disk appears more or less luminous to the eye of the observer, the probable error of a solar altitude taken at sea can hardly be put at less than $\pm$ 1′. The altitude of the lower limb having as a rule been observed, the effect of irradiation would make the measured altitude too low, the latitude too high at noon, too low at midnight, the hour-angles too great west, too small east, the results for longitude east too high on the west side, too low on the east side, for longitude west too low on the west side, too high on the east.

Whenever opportunity offered, which, as a rule, was almost every day, and in particular on arriving at a sounding-station, we corrected our dead-reckoning by means of observations. These were always computed (excepting only meridional altitudes) with two optional latitudes, or, when taken near the meridian, with two optional longitudes. The Tables used were those of the Nautical Almanac. The line of equal altitudes was marked out on the chart as a straight line between the two points thus determined. The ship's position on each of the lines of equal altitudes was computed from the course and the distance run between the observations. I thus determined the latitude and longitude of the observing-stations, and entered the results in the sounding-journal. The dead-reckoning and the observations exhibited in general satisfactory agreement. Meanwhile, we were invariably out of our reckoning after working the dredge or trawl; to calculate the day's work correctly is next to impossible with such operations in hand.

From what has been stated above concerning the rate of our chronometers and the probable error of an observed solar altitude, it is evident that the values for the latitude and longitude of the observing-stations will have a probable error of from 1 to 2 minutes. For the greater part of them, the error will not much exceed a minute.

Der findes imidlertid blandt vore Stationer nogle, hvor Usikkerheden af den paaværende Plads gaar op til 5 à 6 Minuter, nemlig udenfor den nordvestlige Del af Spidsbergen, nordenfor 78° Bredde. Efterat den paaværende Plads var bestemt ved Solobservationer saavel Formiddag som Eftermiddag, viste det sig, da vi fik Land i Sigte, at Resultatet af Pejlinger af Nordpynten af Pr. Charles Foreland gav en 5′ til 6′ sydligere Plads end Solobservationerne. Men Aarsagen viste sig ogsaa i en stærk Hildring, der krævede en anden Værdi for Kimmingdalingen end den normale, som var benyttet. Under saadanne Forhold er paaværende Plads umulig at bestemme med vanlig Nøjagtighed efter Solobservationer, selv om man laa for Anker og observerede Højder i alle Azimuther, thi Horizontalrefraktionen vil variere med Retningen og med Dagstiden paa en ganske uperiodisk Maade, der er umulig at bringe i Regning. Et lignende Exempel paa Virkningen af Hildring havde vi om Morgenen den 10de August 1877 udenfor Lofoten. Maaling af Horizontalvinkler mellem kjendte Punkter gav Fartøjet en paaværende Plads, der laa i en betydelig Afstand fra den Stedlinie, som en over den østlige, falske Horizont maalt Solhøjde gav.

Til Slutning skal jeg nævne, at Expeditionen var udrustet med Apparater til at maale Strøm i Overfladen og paa Dybet. Disse kom ikke til Anvendelse, først fordi Vejret det første Aar var saa særdeles ugunstigt, og senere fordi de andre Arbejder, som skulde udføres, krævede al vor Tid og ikke turde forsinkes af Operationer, om hvilke det altid maatte være tvivlsomt, hvorvidt noget brugbart Resultat kunde erholdes. Bestemmelser af Strømmen i Overfladen efter den almindelige nautiske Methode lod sig ikke, undtagen i yderst faa Tilfælde, udføre paa vor Expedition, da Sejladsen under Skrabning, som nævnt, umuliggjorde et skarpt Bestikhold.

Meanwhile, for some of our observing-stations, the possible error of the ship's position amounts to from 5 to 6 miles, viz. those off the north-western extremity of Spitzbergen, in latitude from 78° to 80° N. After determining the ship's position by observations of the sun's altitude, taken before as well as after noon, we found, on sighting land, the bearing of the northern promontory of Prince Charles' Foreland to give a point from 5 to 6 miles farther south than that determined by the solar altitudes. This, however, was obviously the result of mirage; and hence our constant value for the dip of the horizon would not serve. Under such circumstances it is impossible, were the ship at anchor even and the altitudes observed in all azimuths, to determine her position with the usual accuracy by observations of the sun, since the horizontal refraction according to the direction and the time of day will not vary periodically, and its true value cannot be taken into account. A similar instance of the effects of mirage occurred on the morning of the 10th of August 1877, off Lofoten. By measuring horizontal angles between known objects, we found the ship's position to be a considerable distance from the line of equal altitudes marked out from observations of the sun above the eastern delusory horizon.

Finally, I must not omit to mention that the Expedition was provided with instruments for determining both surface and deep-sea currents. These apparatus, however, were not made use of, — at first owing to the very unfavourable weather we encountered on the opening cruise, and afterwards to avoid impeding the chief exploratory work by operations from which it was anything but certain that practical results would be obtained. Nor had we, save in a very few cases, opportunity of determining the surface-current in the usual nautical way, the effect of dredging and trawling, as stated above, inevitably putting us out of our reckoning.

Translated into English by **John Hazeland.**

DEN NORSKE NORDHAVS-EXPEDITION

1876—1878.

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H. MOHN.

2. MAGNETISKE OBSERVATIONER.

C. WILLE.

3. GEOGRAFI OG NATURHISTORIE.

MED 6 FARVETRYKTE BILLEDER, 13 TRÆSNIT OG 2 KARTER.

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CHRISTIANIA.
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H. Mohn. Astronomiske Observationer til Tids- og Stedsbestemmelse.

De i denne Afhandling meddelte astronomiske Observationer gjordes under Expeditionens Ophold i Havn væsentlig med det Maal for Øje at tjene til Grundlag for de Tids- og Azimuthbestemmelser, der udfordredes til de magnetiske Iagttagelser. Ved Siden deraf tilsigtedes ogsaa Bredde- og Længdebestemmelser, der kunde være af geografisk Interesse, som paa Jan Mayen og Spidsbergen. Den gunstige Lejlighed, som de gjennem Telegrafen givne Tidssignaler frembod til Verification af Længden af Punkter paa Kysten af det nordlige Norge, ønskede jeg ogsaa at benytte efter Lejligheden.

Observationerne ere Solhøjder, maalte med Sextant. Af Bestyreren for det astronomiske Observatorium i Christiania, Professor C. Fearnley, fik jeg udlaant en Observatoriet tilhørende Sextant af Troughton, med Kviksølvhorizont og Stativ, det samme Instrument, som Hansteen benyttede paa sin Rejse i Sibirien i Aarene 1828—1830. I Brugen af Instrumentet modtog jeg selv Prof. Hansteens Vejledning paa Observatoriet i 1861. Paa Sextanten aflæses ved Nonien directe 10″. Ved samtlige Observationer benyttedes den lange Kikkert med ca. 10 Ganges Forstørring. Glastaget over Kviksølvhorizonten prøvede jeg, paa Røst, ved at stille det foran Kikkerten paa en Theodolith, der var indstillet paa en god Mire (et Kirkespir); Virkningen af en prismatisk Form af Glassene var saagodtsom umerkelig, og kan neppe udgjøre et Par Sekunder.

Saagodtsom alle de her meddelte Observationer ere gjorte med dette Instrument. Under Jan Mayen observeredes fra Skibsborde ogsaa med et Par andre Sextanter.

Af Uhre havdes i 1876 ombord 3 Boxchronometre, af Kullberg, Frodsham og Mewes samt et Lommechronometer, foruden almindelige Lommeuhre, hvoraf et mig tilhørende Duplexuhr. I 1877 og 1878 havde vi foruden de nævnte Uhre et Boxchronometer af Reid og i 1878 havde

H. Mohn. Astronomical Observations for determining Time, Latitude and Longitude.

The astronomical observations set forth in this Memoir were made during our stay in certain of the harbours at which the Expedition touched, — chiefly to serve as a basis of the time and azimuth determinations required for the magnetical observations. A secondary object lay in performing, if possible, divers latitude and longitude determinations that might prove of geographical interest, as, for instance, on the islands of Jan Mayen and Spitzbergen. Moreover, of the excellent opportunity afforded by the telegraph time-signals to verify the longitude of points on the northern line of the Norway coast, I was specially desirous of taking advantage.

The observations are solar altitudes, measured with the sextant. On application to Professor C. Fearnley, Director of the Astronomical Observatory at Christiania, he kindly lent me a sextant belonging to that establishment, one of Troughton's, furnished with a mercury-horizon and stand, — the identical instrument used by Hansteen on his travels in Siberia (1828—1830). In the use of the instrument Hansteen had himself given me the necessary instructions, at the Observatory, in 1861. The vernier reads 10 seconds. For all the observations, the long telescope, magnifying about 10 diameters, was exclusively used. The glass covering the mercury-horizon I tested at Røst, by placing it in front of the telescope of a theodolite directed to a good mark (a church steeple). The effect resulting from a slightly prismatic form in the glasses was well-nigh inappreciable, amounting as it did to hardly a couple of seconds.

Almost all of the observations were made with this instrument, a very few only having been taken on board with other sextants, off the coast of Jan Mayen.

Of time-keepers, we had on the first cruise, in 1876, 3 box-chronometers, made respectively by Kullberg, Frodsham, and Mewes, and a pocket-chronometer, exclusive of watches, one of which — that belonging to myself — was a duplex lever. In 1877 and 1878, we had in addition a

jeg til Observationsuhr et Lommechronometer, der var prøvet paa Observatoriet i Neufchatel.

Boxchronometrene havde sin Plads ombord i et Skab i Arbeidssalonen. De bleve hver Morgen optrukne og sammenlignede indbyrdes. I 1876 tjente Kullberg som Hoveduhr og i 1877 og 1878 Reid. Kun Hoveduhret har været benyttet til Længdebestemmelserne, da det viste sig at have en meget jevnere Gang end de øvrige. Under Rejserne blev det af de daglige Sammenligninger constateret, at der ikke indtraf nogen merkelig Forrykkelse i Hoveduhrets daglige Gang.

Ved Observationer paa Land eller paa Dæk benyttedes saagodtsom uden Undtagelse et af de andre Boxchronometre eller et Lommechronometer, stundom ogsaa et almindeligt Lommeuhr. I ethvert Tilfælde blev Observationsuhret sammenlignet med Hoveduhret før og efter Observationerne.

Før Expeditionen tiltraadte sine Rejser, bleve Boxchronometrene, med Undtagelse af Reid, daglig sammenlignede med Pendeluhret paa Observatoriet i Bergen af dettes Bestyrer, Hr. Åstrand. Under Expeditionens Ophold i norske Havne blev deres Stand for Greenwich Middeltid bestemt ved de fra Observatoriet i Christiania gjennem Telegrafen givne Tidssignaler. Disse gives hver Søndag og hver Onsdag Morgen. Signalapparatet (Morse's) staar lige ved Siden af Observatoriets Normalpendel. Der gives hver Gang 3 Signaler, nemlig $8^h\ 59^m\ 0^s$, $9^h\ 0^m\ 0^s$ og $9^h\ 1^m\ 0^s$ Greenwich Middeltid om Søndagene og $7^h\ 59^m\ 0^s$, $8^h\ 0^m\ 0^s$ og $8^h\ 1^m\ 0^s$ om Onsdagene. Tidssignalet, der høres meget skarpt paa Modtagelsesstationens Morse-Apparat, bestaar i et enkelt Slag. For at skille mellem de 3 Signaler slaaes efter det første 1 Dobbeltslag, efter det andet 2 og efter det 3die Signal 3 Dobbeltslag. Signalerne sendes til alle norske Telegrafstationer.

Med Hensyn til Nøjagtigheden af de i det Følgende givne Tids-, Længde og Bredde-Bestemmelser maa jeg bemerke Følgende:

Den af Beregningerne udledede sandsynlige Fejl af en enkelt observeret Højde (paa Land med Stativ og Kviksølvhorizont) er omkring $\pm\ 5''$. Der er imidlertid, som det paa sit Sted skal vises, Tegn til, at der, foruden de egentlige tilfældige Observationsfejl, optræder constante Fejl, hvis Aarsag kunne ligge i forskjellige Omstændigheder, som i Bestemmelsen af Indexfejlen, mangelfuld Justering af Instrumentet, Excentricitet m. m. Hvad Indexfejlen angaar, da er den i Regelen bestemt samtidig med Observationerne og ved gjennemsnitlig 4 Satser Dobbeltcontacter af Solranderne. Middelfejlen af Resultatet af en enkelt Sats finder jeg at være $\pm\ 5''.7$ og Middelfejlen for en Bestemmelse af Indexfejlen skulde saaledes være $\pm\ 2''.85$. Instrumentet holdtes altid godt justeret og om Excentricitet af nogen merkelig Virkning nævner Prof. Hansteen ikke Noget. Ved Observationerne i Hammerfest (Fuglenes) og i Bodø antydes imidlertid Tilstedeværelsen af constante Feil i Højden af respektive $+8''$ og $-8''$. En Del heraf kunde

box-chronometer by Reid, and in the latter year I took observations with a pocket-chronometer, tested at the Observatory of Neufchatel.

The box-chronometers were kept in a cupboard in the work-room. They were wound up every morning and duly compared. In 1876, Kullberg's served as chief time-keeper, in 1867 and 1878 that by Reid. For determinations of longitude, exclusive use was made of the chief time-keeper, its rate having proved much more uniform than that of the other chronometers. On each cruise the result of the daily comparison showed that no appreciable disturbance had occurred in the diurnal rate of the chief time-keeper.

For observations on shore, or from the deck of the vessel, we used almost without exception one of the other box-chronometers, or a pocket-chronometer, nay sometimes a watch. The chronometer or watch, whichever it might be, was, however, invariably compared with the chief time-keeper both before and after the observations.

Previous to the departure of the Expedition on its several cruises, the box-chronometers, with the exception of Reid's, were daily compared with the standard-clock of the Bergen Observatory, by the Director, Mr. Åstrand. During the stay of the Expedition at Norwegian ports, their error on Greenwich mean time was determined by the time-signals telegraphed from the Observatory at Christiania. These signals are sent every Sunday and Wednesday morning. The signalling apparatus (Morse's) stands close beside the standard-clock of the Observatory. Three signals are given, viz. at $8^h\ 59^m\ 0^s$, $9^h\ 0^m\ 0^s$, and $9^h\ 1^m\ 0^s$, Greenwich mean time, on Sundays, and at $7^h\ 59^m\ 0^s$, $8^h\ 0^m\ 0^s$ and $8^h\ 1^m\ 0^s$ on Wednesdays. Each signal, distinctly delivered by the apparatus of the receiving-station, consists of a single click. As a means of readily distinguishing between the 3 signals, the first is followed by a double-click, the second by 2 double-clicks, and the third by 3. These signals are transmitted to all Norwegian telegraph-stations.

As regards the accuracy of the observations for determining time, latitude, and longitude, I must observe as follows: —

The computed probable error of a single observed altitude (using on shore the sextant with a stand and mercury-horizon) is about $\pm\ 5''$. Meanwhile, there is reason to believe, as will afterwards appear, that, apart from the accidental errors of observation, certain constant errors occur, arising probably from various sources, such as the determination of the index-error, imperfect adjustment of the instrument, excentricity, &c. With regard to the index-error, this has usually been determined when taking the observations, and on an average from 4 sets of double contacts of the solar limbs. The mean error of the result of one double contact I found to be $\pm\ 5''.7$, and the mean error of the determination of the index-error should accordingly have been $\pm\ 2''.85$. The instrument was always kept well adjusted, and of excentricity that could have any appreciable effect, Hansteen says nothing whatever. Meanwhile, the observations taken at Hammerfest (Fuglenes) and at Bodö indicate the existence of constant errors in the

muligens tilskrives Ujevnhed i Chronometrets Gang, men saameget bliver tilbage som Fejl i Højderne, at jeg anser det rigtigst at antage, at mine Højder, med et rundt Tal, kunne være beheftede med en sandsynlig constant Fejl for hver Station af $\pm$ 10″.

Paa den Nøjagtighed, hvormed Observationsuhret angiver Greenwich Middeltid, har jeg søgt at faa et Maal ved følgende Overslag:

Observationsuhrets Sammenligning med Hoveduhret. Der toges flere Sammenligninger før og efter Højdeobservationerne. Af disse finder jeg for 1877, mit Duplexuhr, en sandsynlig Fejl af den anvendte Uhrforskjel af $\pm$ 0.ˢ15 (efter 4 Sammenligninger) og $\pm$ 0.ˢ11 af 4 Sammenligninger før og 4 efter Observationerne. For 1878 finder jeg for Sammenligningen mellem mit Lommechronometer og Chronometer Reid saavel i Søen som i Havn, Middelfejlen af en enkelt Sammenligning $\pm$ 0.ˢ10. I Regelen gjordes 3 Sammenligninger, saaat Middelfejlen ved en Sammenligning før eller efter Højdeobservationerne kan sættes til $\pm$ 0.ˢ06 og af Mediet af begge til $\pm$ 0.ˢ04. Jeg kalder i det følgende denne sandsynlige Fejl D_1 og sætter med et rundt Tal $D_1 = \pm$ 0.ˢ1.

Naar Tidssignal skulde observeres, var Regelen den, at Skibschefen, Capt. Wille, først sammenlignede Observationsuhret, et Lommechronometer, der slog 0.ˢ4, med Hovedchronometret, derpaa gik i Land paa Telegrafkontoret og efter Tilbagekomsten ombord atter tog en Uhrsammenligning. Jeg antager, efter et Skjøn, denne Operations Resultat at have en sandsynlig Fejl af $\pm$ 0.ˢ1, som jeg kalder D_2.

Paa Telegrafkontoret observerede Capt. Wille Tidssignalerne efter Observationsuhret. Den sandsynlige Fejl af Observationen af et enkelt Signal antager jeg at kunne sætte til $\pm$ 0.ˢ2. Da i Regelen neppe mere end 2 af de 3 Signaler kunne antages at blive godt observerede (ved de 2 sidste er man forberedt paa Secundet), sætter jeg den sandsynlige Fejl af Resultatet af Observationen af Tidssignalerne til $\pm$ 0.ˢ15 (D_3). Ved en Lejlighed, da vi begge observerede Tidssignalerne, stemte vor Bestemmelse af Hovedchronometrets Stand paa 0.ˢ1.

Ved Signalets Afsendelse paa Observatoriet i Christiania kan den sandsynlige Fejl, efter Vidnesbyrd fra vedkommende Astronomer, sættes til 0.ˢ15 pr. Signal, $\pm$ 0.ˢ10 pr. 2 Signaler (D_4).

Ligeledes sættes den sandsynlige Fejl af Normalpendelens beregnede Stand for Christiania Stjernetid, corrigeret efter efterfølgende Tidsbestemmelse, til $\pm$ 0.ˢ1 (D_5).

Den sandsynlige Fejl af den nedenfor antagne Tidsforskjel mellem Christiania og Greenwich Observatoriers Meridianer sættes til $\pm$ 0.ˢ2 (D_6).

Ved Længdeberegningerne er forudsat en jevn Gang hos Hovedchronometret mellem de Tidspunkter, da dets

altitude amounting respectively to +8″ and −8″. Some part of this error may perhaps be ascribed to want of uniformity in the rate of the chronometer; but even with this deduction, the remainder is, I think, as an actual error in the altitudes, sufficient to warrant assuming that my solar altitudes may be affected by a probable constant error at each Station of $\pm$ 10″.

Of the precision with which the chronometer used for noting the observations indicates Greenwich mean time, I have sought to find a measure as follows: —

Comparison of the watch or chronometer selected for the observation with the chief time-keeper. Several comparisons were made before and after the observations of altitude. Now, for 1877 (my duplex watch), I find a probable error of the assumed difference of the errors of the time-pieces (4 comparisons) of $\pm$ 0.ˢ15, and with 4 comparisons before and 4 after the observations, of $\pm$ 0.ˢ11. For 1878, I find the mean error of a single comparison between my pocket-chronometer and the box-chronometer by Reid, both at sea and in harbour, to have been $\pm$ 0.ˢ10. The number of comparisons having, as a rule been three, the mean error of one comparison before or one after a series of altitudes may be put at $\pm$ 0.ˢ06, and the mean error of two comparisons, one before and one after, at $\pm$ 0.ˢ04. In the sequel I shall call this probable error D_1, and assume $D_1 = \pm$ 0.ˢ1.

The time-signals were generally observed as follows: — Shortly before their arrival, the commander of the vessel, Capt. Wille, compared a pocket-chronometer, beating 0.ˢ4, with our chief time-keeper. He then went on shore to the telegraph-office, observed the signals, and, on his return to the ship, again compared the respective time-pieces. The probable error of these comparisons on board may, I think, be estimated at $\pm$ 0.ˢ1, which I shall call D_2.

At the telegraph-office Capt. Wille observed the time-signals with the pocket-chronometer mentioned above. The probable error of the observation of one signal I have put at $\pm$ 0.ˢ2. Now, as only 2 of the 3 signals, on an average, will be accurately observed (for the 2 last the observer is prepared to the second), I shall estimate the probable error of the result of our observations of the time-signals at $\pm$ 0.ˢ15 (D_3). On one occasion, when both of us (myself and Capt. Wille) observed the time-signals, our determination of the error of the chief chronometer agreed within 0.ˢ1.

According to the estimate of the astronomers of the Christiania Observatory, the probable error of one signal as given with the key at the Observatory may be put at $\pm$ 0.ˢ15, of two signals $\pm$ 0.ˢ10 (D_4).

The probable error of the computed error of the standard clock on Christiania sidereal time, corrected from later transits of stars, is put at $\pm$ 0.ˢ1 (D_5).

The probable error of the difference in time, as given below, between the meridians of the Christiania and Greenwich Observatories, is put at $\pm$ 0.ˢ2 (D_6).

For computations of longitude, the chief chronometer is assumed to have had a uniform rate between the moments

Stand er bestemt ved Tidssignaler. Den sandsynlige Fejl eller Afvigelse fra den absolut jevne Gang sætter jeg, da den midlere Gang hos Chronometret Reid viser sig saa udmerket jevn, til $\pm$ 0.s25 (D_i).

Den galvaniske Strøm, ved hvilken Tidssignalerne gives, gaar ikke directe gjennem alle Stationers Apparater, men sendes ved Overdrag videre fra visse Overdragsstationer. For de Stationers Vedkommende, hvorom her er Spørgsmaal, er der Overdrag i Christiania, Throndhjem, Lødingen og Kistrand. Ved Overdragene lider Signalet en Forsinkelse. Størrelsen af denne fik jeg ved Telegrafdirektør Nielsen's og Telegrafintendant Collett's Velvilje bestemt paa følgende Maade: Strømmen sendtes fra Christiania over Throndhjem til Lødingen og tilbage til Christiania ad to forskjellige Traade med 3 Overdrag paa Vejen. Det med en Nøgel givne Signal kom igjen og hørtes paa et ved Siden af Afsendelsesapparatet staaende Apparat. Naar jeg signalerede med Nøglen i Takt og Coincidents med mit Lommechronometer, hørtes det tilbagekommende Signal midt imellem de med Nøglen givne Signaler. Da mit Uhr slaar 4 Tiendedels Secunder, var Signalets Forsinkelse 0.s20 for 3 Overdrag. Sættes Forsinkelsen lige stor for hvert Overdrag, bliver den 0.s07 for hvert, og altsaa for 2 Overdrag 0.s14, og for 4 Overdrag 0.s28.

Ved Beregningen af Normalpendelens Angivelse for Signaløjeblikket er gaaet ud fra en Tidsforskjel af 0^h 42^m 54.s5 mellem Christiania og Greenwich. Efter den af Prof. Auwers i Geographisches Jahrbuch für 1880 givne Tabel over de vigtigste Observatoriers Bredde og Længde er den nævnte Tidsforskjel 0^h 42^m 53.s8. Forskjellen mellem de to Tal beror paa de nyere telegrafiske Bestemmelser af Længden af Kjøbenhavns Observatorium, med hvilket Christianias er forbundet chronometrisk. Idet jeg gaar ud fra den nyere Bestemmelse, bliver følgelig Klokkeslettet i Greenwich i Signaløjeblikket 0.s7 større end oprindelig antaget.

Observator Geelmuyden har velvilligen meddelt mig de corrigerede Tidspunkter for Signalernes Afsendelse, der ere beregnede efter Tidsbestemmelser gjorte saavel før som efter Signalernes Afsendelse. Den følgende Tabel viser de efter de oven anførte Correctioner, Strømtid, Længdecorrection og senere Tidsbestemmelser, rettede Signaløjeblikke, som ere observerede under Expeditionen, samt Hovedchronometrenes Stand og Gang.

at which its error was found by the time-signals. The probable error or deviation from a uniform rate, I shall put — the mean rate of the Reid chronometer having proved so remarkably uniform — at $\pm$ 0.s25 (D_i).

The galvanic current by which the time-signals are transmitted, does not reach every station direct, being sent on by relays from certain stations selected for that purpose. As regards the stations at which the time-signals were observed on the Expedition, the relay-stations were at Christiania, Throndhjem, Lödingen, and Kistrand. These breaks occasion some loss of time in transmitting the signal. The approximate extent of the delay I was enabled by the kindness of Mr. Nielsen, Director of Telegraphs, and of Mr. Collett, Electrician, to determine as follows: — The galvanic current was transmitted from Christiania, viâ Throndhjem, to Lödingen, and thence back to Christiania, by two different wires, and broken by three relays. The signal, given with a key, came back, being distinctly delivered from another apparatus, also standing beside the observer. When signalling with the key, its clicks coinciding with the beats of my pocket-chronometer, the returning signal would be heard at the mid-point of the interval between two successive signals given with the key. Now, as my pocket-chronometer beats four-tenths of a second, the delay in transmitting a signal must have been 0.s20 with three relays; hence, with one relay, assuming it equal for each, the delay will be 0.s07, with two relays 0.s14, and with four 0.s28.

In computing the indication of the standard-clock for the moment of the despatch of a signal, the difference in time between Christiania and Greenwich has been put at 0^h 42^m 54.s5. According to the Table furnished by Professor Auwers in Geographisches Jahrbuch for 1880, showing the latitude and longitunde of the chief Observatories, the difference is 0^h 42^m 53.s8. The want of agrement in the respective figures must be ascribed to the late telegraphic determination of the longitude of the Copenhagen Observatory, with which that at Christiania is chronometrically connected. Taking the latter of the two determinations, the assumed Greenwich time at the moment of despatch will require a correction of + 0.s7.

Mr. Geelmuyden, of the Christiania Observatory, has kindly furnished me with the corrected moments for the despatch of the signals, computed from transists observed alike before and after transmission. In the following Table will be found the moments of despatch for the signals observed on the Expedition, corrected for the above-specified errors, viz. the propagation of the current, correction of assumed longitude, and subsequent determinations of clock error — as also the error and rate of the chief chronometers.

Sted. (Place.)	Datum. (Date.)	Greenwich Middeltid. (Greenwich Mean Time) a. m.	Hovedchronometer Corr. til G. M. T. (Standard Chronometer. Corr. to G. M. T.)	Daglig Gang. (Daily Rate.)
Christiansund .	1876 Juni (June) 25	9^h 0^m $0.^s0$	-0^h 38^m $59.^s6$	
Namsos . . .	„ Aug. (Aug.) 20	9 0 0.8	-0 39 32.8	$0.^s59$
Bergen . . .	1877 Maj (May) 23	8 0 0.7	$+0$ 7 23.7	
Bodø	„ Juni (June) 24	9 0 0.9	7 54.9	0.97
Tromsø . . .	„ Juli (July) 11	8 0 0.9	8 10.9	0.94
Tromsø . . .	„ Juli (July) 22	8 59 59.3	8 20.5	0.87
Bodø	„ Aug. (Aug.) 12	9 0 1.3	8 40.8	0.97
Hammerfest . .	1878 Juni (June) 23	9 0 1.0	$+0$ 15 5.5	
Hammerfest . .	„ Juli (July) 10	8 0 1.2	0 15 20.2	0.87
Hammerfest . .	„ Juli (July) 28	9 0 1.0	0 15 37.5	0.96
Tromsø . . .	„ Aug. (Aug.) 28	8 0 0.8	0 16 7.6	0.97

I. Husø.

En liden Ø ved Sognefjordens Munding. Sterk Nordenvind. Observationerne gjordes i Læ af Hr. Lexaus Hus. Efter Kystkartet er Bredden $\varphi = 60^0\ 59.'6$. Længden $\lambda = 4^0\ 37' = 18^m\ 28^s$ E. Greenwich $= 2^m\ 41^s$ W. Bergen. Corresponderende Højder. Chronometer Mewes No. 575. 2h' = aflæst dobbelt Højde. T_0 ucorrigeret Middag. ΔT_0 Middagscorrection. E. Tidsjevning. MT Middeltid.

I. Husø.

A small island at the mouth of the Sognefjord. Blowing hard from the north. The observations were taken to leeward of Mr. Lexau's house. On the coastal chart, the latitude, φ, is $60^0\ 59.'6$, the longitude, λ, $4^0\ 37' = 18^m\ 28^s$ E. Greenwich $= 2^m\ 41^s$ W. Bergen. Equal altitudes. Chronometer, Mewes No. 575. 2h' signifies Observed double altitude; T_0 Mean of all chronometer-times; ΔT_0 Equation of equal altitudes; E Equation of time; MT Mean time.

1876. Juni (June) 10.

⊙ 2h'	Chron. a. m.	Chron. p. m.	T_0
89^0 30'	22^h 6^m $59.^s5$	2^h 48^m $34.^s0$	0^h 27^m $46.^s75$
50	8 51.0	46 44.0	47.5
90 0	9 45.5	45 48.5	47.0
10	10 42.0	44 52.5	47.25
20	11 37.0	43 56.5	46.75
30	12 33.0	43 1.0	47.0
40	13 29.5	42 3.0	46.25
50	14 27.0	41 6.0	46.5
91 0	15 25.5	40 9.0	47.25
10	16 22.5	39 12.5	47.5
20	17 21.0	38 12.5	46.75
30	18 18.0	37 14.5	46.25
40	19 17.0	36 17.9	47.45
50	20 14.7	35 19.0	46.85
92 0	21 15.0	34 20.0	47.5

$T_0 =$	0^h 27^m $46.^s97$
$\Delta T_0 =$	-4.34
	0 27 42.63
E =	47.32
Mewes foran Husø Middeltid (Fast on Husø M. T.)	0 28 29.95
Reduction t. (to) Bergen	2 41.
Correction t. (Error on) Bergen M. T.	-0^h 25^m $49.^s$

Maj *(May)* 30	$2.^h55$	Corr. t. *(Error on)*	Bergen M. T. =	— 0	24' 44.3
Juni *(June)* 10	0. 45	„ (— „)	— „ „ =	0	25 49.0
		Daglig Acceleration *(Gaining daily)*			5.93

2. Reykjavik.

Den 1ste August 1876 toges af Capt. Wille og Lieutn. Petersen følgende corresponderende Højder paa den grønne Plæne ved Konsul Simsons Hus. $\varphi = 64^\circ\ 9.'0$, $\lambda = 1^h\ 27^m\ 36.^s6$ W. Gr. Chronometer Kullberg.

2. Reykjavik.

On the 1st of August, 1876, Capt. Wille and Lieut. Petersen took the following equal altitudes from the grass-plot adjoining Mr. Simson's house. $\varphi = 64^\circ\ 9.'0$, $\lambda = 1^h\ 27^m\ 36.^s6$ W. Gr. Kullberg's chronometer.

⊙ 2h'	Chron. a. m.	Chron. p. m.	$T_0 + \Delta T_0$
75° 0'	$23^h\ 49^m\ 8.^s0$	$4^h\ 36^m\ 10.^s0$	$2^h\ 12^m\ 57.^s75$
10	50 12.5	35 5.5	57.73
20	51 17.5	34 0.0	57.44
30	52 24.5	32 55.0	58.41
40	53 29.5	31 48.0	57.38
50	54 40.5	30 40.5	59.10
76 0	55 45.5	29 31.5	57.08
76 40	0 0 18.5	4 25 1.5	57.96
50	1 26.0	23 52.0	56.43
77 0	2 37.0	22 40.5	57.15
10	3 49.0	21 31.0	58.38
20	4 58.0	20 21.0	57.85
30	6 9.5	19 11.5	58.82
40	7 18.5	17 57.0	56.04
			2 12 57.08 ± $0.^s13$
		E.:	6 2.06
	Chron. Corr. t. *(Error on)*	Reykjavik M. T.	$2^h\ 6^m\ 55.^s02$
	— „ (— „)	Greenwich —	39 21.8
		Reykjavik W. Greenwich	$1^h\ 27^m\ 33.^s8$

Sættes $D_1 = 0$, da Hovedchronometret anvendtes til Observationerne, $D_2 = \pm\ 0.^s1$, $D_3 = \pm\ 0.^s15$, $D_4 = \pm\ 0.^s1$, $D_5 = \pm\ 0.^s1$, $D_6 = \pm\ 0.^s2$, $D_7 = \pm\ 0.^s25$, saa bliver den sandsynlige Fejl af den beregnede Længde

Now, putting $D_1 = 0$, the observations having been taken with the chief chronometer; $D_2 = \pm\ 0.^s1$, $D_3 = \pm\ 0.^s15$, $D_4 = \pm\ 0.^s1$, $D_5 = \pm\ 0.^s1$, $D_6 = \pm\ 0.^s2$, $D_7 = \pm\ 0.^s25$, the probable error of the computed longitude will be

$$D_\lambda = \pm \sqrt{(0.^s13)^2 + D_2^2 + D_3^2 + D_4^2 + D_5^2 + D_6^2 + D_7^2} = \pm\ 0.^s41$$

Den af ovenstaaende Observationer beregnede Længde stemmer paa $2.^s7$ med den, der ifølge de Opgaver, som velvillig ere mig meddelte af Commandør Rothe, Director for det Kongelige Danske Søkaart-Archiv i Kjøbenhavn, efter tidligere Iagttagelser og Beregninger er antaget som den sandsynligste, nemlig $1^h\ 27^m\ 36.^s6$. Observations-

The longitude computed from the observations given above agrees within $2.^s7$ with that which, according to the results kindly furnished me by Commodore Rothe, Hydrographer to the Royal Danish Navy, from former observations and computations, is deemed the most probable, viz. $1^h\ 27^m\ 36.^s6$, the point of observation lying about 38″,

punktet ligger nemlig 38″ eller 2.ˢ5 østenfor det Punkt ved Reykjavik, hvis Længde er antaget at være 21° 54′ 46″ eller $1^h\ 27^m\ 39.^s1$.[1]

or 2.ˢ5, east of a point at Reykjavik of which the longitude is assumed to be 21° 54′ 46″, or $1^h\ 27^m\ 39.^s1$.[1]

3. Namsos.

Correspondérende Højder. $\varphi = 64°\ 28.'2$. $\lambda = 0^h\ 46^m\ 6^s$ E. Greenw. Observationerne gjordes paa Nordsiden af Byen, c. 20 Skridt fra Stranden. Chron. Frodsham.

3. Namsos.

Equal altitudes: $\varphi = 64°\ 28.'2$: $\lambda = 0^h\ 46^m\ 6^s$ E. Gr. The observations were taken north of the town, about 20 paces from the shore. Frodsham's chronometer.

1876. August 19.

⊙ 2h′	Chron. a. m.	Chron. p. m.	$T_0 + \Delta T_0$
72° 50′	$22^h\ 7^m\ 26.^s5$	$0^h\ 54^m\ 47.^s0$	$23^h\ 31^m\ 30.^s94$
73 0	9 14.5	52 58.5	30.67
73 10	11 5.0	51 7.0	30.14
20	13 0.0	49 12.5	30.35
30	15 0.5	47 20.5	34.57
40	16 54.0	45 19.0	30.54
50	18 50.5	43 21.0	29.73
74 0	21 2.0	41 15.0	32.48
10	23 9.0	39 7.5	32.21
			23 31 31.29 ± 0.ˢ34
		E.	0 3 19.14
		Corr. t. *(Error on)* Namsos M. T.	+ 0 31 47.85

Den 19de August, $21^h\ 0^m\ 0.^s8$ Greenwich M. T., var, ifølge Tidssignal pr. Telegraf, observeret directe efter Frodsham, af Capt. Wille, dette Chronometer $14^m\ 23.^s0$ foran Greenwich M. T. Da Chronometret accelerede 5.ˢ12 i 24^h, bliver for Signaløjeblikket dets Correction til Namsos Middeltid $+ 31^m\ 43.^s22$, og den af disse Tal resulterende Længde for Namsos

$$\lambda = 0^h\ 46^m\ 6.^s22 \text{ E. Greenwich}$$

med en sandsynlig Fejl af

On the 19th of August, $21^h\ 0^m\ 0.^s8$ Greenwich M. T., Capt. Wille found the Frodsham chronometer, with which he observed the time-signals, to be $14^m\ 23.^s0$ fast on Greenwich M. T.; and hence, gaining as it did 5.ˢ12 in twenty-four hours, the error on Namsos M. T. for the moment of despatch will be $+ 31^m\ 43.^s22$, and the longitude of Namsos computed from these figures,

$$\lambda = 0^h\ 46^m\ 6.^s22 \text{ E. Greenw.}$$

with a probable error of

$$\pm \sqrt{(0.^s34)^2 + D_3^2 + D_4^2 + D_5^2 + D_6^2 + D_7^2} = \pm 0.^s49$$

Efter det af den geografiske Opmaaling construerede, endnu ikke udgivne, nyeste Kart over disse Egne ligger mit Observationspunkt 0° 46′ 29″ eller $0^h\ 3^m\ 5.^s9$ E. Christiania, og skulde saaledes, med den her antagne

On the latest charts of these regions, constructed by the Geographical Survey but not yet published, my point of observation lies 0° 46′ 29″, or $0^h\ 3^m\ 5.^s9$ E. Christiania, and should therefore, with the longitude here assumed

[1] Se ogsaa "Geografisk Tidskrift", udgivet af Bestyrelsen for det kongelige danske geografiske Selskab, 4de Bind, 1880, S. 111, 112.

[1] See also "Geografisk Tidskrift," edited by the Directors of the Royal Danish Geographical Society, Vol. 4, 1880, pp. 111, 112.

Længde for Christiania, 0^h 42^m $53.^s8$, ligge 0^h 45^m $59.^s7$ E. Greenwich, det er $6.^s5$ vestligere, end min astronomiske Bestemmelse giver. Nogen Grund til denne betydelige Forskjel formaar jeg ikke at angive.

for that place, viz. 0^h 42^m $53.^s8$, lie 0^h 45^m $59.^s7$ E. Greenwich, that is, $6.^s5$ farther west than determined by my astronomical observations. Any reason for so considerable a difference I am unable to suggest.

4. Bodø.

Samtidig med at Capt. Wille gjorde magnetiske Observationer, tog jeg den 13de August 1877 en Række Solhøjder paa et Sted nogle hundrede Skridt østenfor den østligste Landgangsbrygge. En Del af Højderne vare correspondereude, en Række var Circummeridianhøjder, og senere om Eftermiddagen toges, med lav Solstand, en kort Række absolute Højder. Til de fleste Observationer benyttede jeg Chronometer Frodsham, men til nogle af Circummeridianhøjderne mit Duplexuhr, hvis Angivelser, efter samtidige Sammenligninger, umiddelbart reduceredes til Frodsham. Dette Chronometer sammenlignede jeg med Normalchronometret Reid Morgen og Aften.

Frodsham	19^h 54^m $30.^s0$		7^h 0^m $30.^s0$
Reid	18 50 46. 5		5 56 44. 25
Fr. Corr. t. Reid	— 1 3 43. 5		— 1 3 45. 75

Sextantens Indexfejl fandtes:

Før Middag	+ 1′ 58.″1 ± 1.″8	4	Observationer.
Efter Middag	+ 1 50. 3 ± 5. 2	4	—
Om Aftenen	+ 1 63. 5 ± 1. 7	4	—

Højderne ere beregnede med en Indexfejl af + 1′ 57.″3 indtil Frodsham 12^h 10^m 55^s og de følgende med + 1′ 59.″5.

Efter de ombord gjorte meteorologiske Iagttagelser var

Kl. 8 a. m.	Barometer	770.^{mm}2,	Temperatur	21.^{0}0 C.
„ 2 p. m.	—	69. 8,	—	21. 0
„ 8 p. m.	—	69. 3,	—	16. 0

Efter en foreløbig Beregning fandt jeg som approximative Værdier af Bredden og Længden $\varphi_0 = 67^0\ 17'\ 10''$ og $\lambda_0 = 0^h\ 57^m\ 39.^s6$. Kaldes den af disse Værdier for hvert Observationsøjeblik beregnede Højde af Solens Centrum h_0, den af Observationerne, rettede for Indexfejl, Refraction, Parallaxe og Solradius, fundne Højde h, den sandsynligste Værdi af Bredden og Længden $\varphi_0 + \Delta\varphi$ og $\lambda_0 + \Delta\lambda$, saa giver hver Observation en Ligning af Formen

$$-\cos a\ \Delta\varphi - \cos\varphi\ \sin a\ \Delta\lambda = h - h_0$$

hvor a er Azimuth. Af samtlige Ligninger udledes ved de mindste Kvadraters Methode de sandsynligste Værdier af $\Delta\varphi$ og $\Delta\lambda$. Denne sidste Beregning er udført af Bestyreren af Bergens Observatorium, Hr. Astrand, der efter min Anmodning velvillig paatog sig dette Arbejde.

Grupperes Differentserne mellem de observerede og de efter de fundne sandsynligste Værdier for Bredden og

4. Bodø.

Whilst Capt. Wille was engaged in making magnetical observations, I took on the 13th of August, 1877, a series of solar altitudes, from a point a few hundred paces east of the most easterly landing-pier. Part of them were equal altitudes, part (one series) circum-meridian altitudes, and later in the afternoon I took a short series of absolute altitudes. For most of the observations I used the Frodsham chronometer; but for some of the circum-meridian altitudes, my duplex watch, its indications, however, having been immediately compared with, and reduced to, those of the Frodsham. This chronometer I myself compared morning and evening with the Reid, our chief timekeeper.

Frodsham	19^h 54^m $30.^s0$		7^h 0^m $30.^s0$
Reid	18 50 46. 5		5 56 44. 25
Fr. Corr. to Reid	— 1 3 43. 5		— 1 3 45. 75

The index-error of the sextant was found to be —

Before Noon	+ 1′ 58.″1 ± 1.″8	4	Observations.
After Noon	+ 1 50. 3 ± 5. 2	4	—
In the Evening	+ 1 63. 5 ± 1. 7	4	—

The altitudes have been computed with an index-error of + 1′ 57.″3 up to 12^h 10^m 55^s Frodsham, and the remainder with an error of + 1′ 59.″5.

The results of the meteorological observations taken on board, were as follows: —

8 a. m.	Barometer	770.^{mm}2,	Temperature	21.^{0}0 C.
2 p. m.	—	69. 8,	—	21. 0
8 p. m.	—	69. 3,	—	16. 0

As approximate values for latitude and longitude, a preliminary computation gave $\varphi_0 = 67^0\ 17'\ 10''$ and $\lambda_0 = 0^h\ 57^m\ 39.^s6$. Now, if the altitude of the sun's centre, computed for each moment of observation from these values, be called h_0, the altitude found from the observations, after correction for the index-error, refraction, parallax, and the sun's semidiameter, h, the probable value of the latitude and longitude, $\varphi_0 + \Delta\varphi$ and $\lambda_0 + \Delta\lambda$, — then each observation will give an equation of the following form —

$$-\cos a\ \Delta\varphi - \cos\varphi\ \sin a\ \Delta\lambda = h - h_0$$

in which a signifies the azimuth. From all the equations were found, by the method of the least squares, the most probable values of $\Delta\varphi$ and $\Delta\lambda$. This computation was made by Mr. Astrand, Director of the Bergen Observatory, who at my request kindly undertook the work.

On grouping the differences between the observed altitudes and the altitudes computed from the most pro-

Længden beregnede Højder efter de observerede Solrender, finder man, at i Gjennemsnit give nedre Solrands Observationer Højderne 6.″8 for store, og øvre Solrands 6.″6 for smaa. Den i Beregningen benyttede Solradius, 15′ 59.″5, er saaledes for stor og bør, for at bringes i Overensstemmelse med Observationerne, formindskes til 15′ 52.″8. Beregnes med denne Værdi faar man de nedenstaaende Værdier for Forskjellen mellem observerede og beregnede Højder, hvis Kvadratsum er Minimum.

bable values resulting for the latitude and longitude according to the observed solar limbs, the lower-limb observations are found to give on an average the altitudes 6.″8 too high, the upper-limb 6.″6 too low. Hence, the assumed semidiameter of the sun, — 15′ 59.″5, will be too great, and should, to make it agree with the observations, be reduced to 15′ 52.″8. Computed with these figures, we get the subjoined values for the difference between observed and computed altitudes, the sum of the squares of which is a minimum.

1877. August *(August)* **12—13.**

Chron. Frodsham.	Dobbelt aflæst Højde. *(Double obs. Altitude.)*	Obs. — Ber. Højde. *(Obs. — Calc. Alt.)*	Chron. Frodsham.	Dobbelt aflæst Højde. *(Double obs. Altitude.)*	Obs. — Ber. Højde. *(Obs. — Calc. Alt.)*
21h 26m 35.s0	⊙ 62° 40′ 0″	+ 8″	0h 4m 22.s0	75° 8′ 5″	+ 1″
27 51.5	50 0	— 4	5 40.0	8 5	+ 3
29 8.5	63 0 0	— 19	7 51.0	7 0	— 1
30 23.0	10 0	— 18	9 7.0	6 55	+ 11
31 35.5	20 0	— 9	10 57.0	5 40	+ 2
32 50.0	30 0	— 5	12 2.0	5 0	+ 2
34 4.7	40 0	— 8	13 8.0	4 35	+ 13
35 22.5	50 0	+ 8	14 12.0	3 20	— 5
36 35.5	64 0 0	+ 3	15 16.0	2 20	— 5
21 38 44.5	⊙ 65 20 0	— 8	0 21 14.0	⊙ 73 52 50	— 3
40 4.0	30 0	— 14	22 55.0	50 40	— 4
41 23.0	40 0	— 17	25 9.0	47 20	— 10
42 42.0	50 0	— 17	26 26.0	45 20	— 15
44 1.5	66 0 0	— 16	27 21.0	44 15	— 4
45 19.5	10 0	— 11	28 12.0	42 55	— 4
46 40.0	20 0	— 8	29 25.0	41 0	— 1
48 1.0	30 0	— 7	30 25.0	39 0	— 11
49 23.0	40 0	— 7	31 24.0	37 20	— 6
23 17 52.0	⊙ 74 10 0	+ 9	0 36 27.0	⊙ 74 31 5	— 13
19 47.0	14 30	— 14	37 33.0	28 40	0
20 51.0	18 15	+ 20	38 32.0	26 30	— 1
21 47.0	20 0	+ 5	39 25.0	24 20	— 4
22 33.0	22 0	+ 7	40 22.0	22 0	— 7
23 33.0	24 20	+ 8	41 18.0	20 0	0
24 25.0	26 30	+ 13	42 18.0	18 15	+ 14
25 28.0	28 40	+ 5	43 18.0	14 30	— 14
26 35.0	31 5	+ 7	45 13.0	10 0	+ 1
23 29 45.0	⊙ 73 33 50	0	2 13 45.0	⊙ 66 40 0	+ 7
31 20.0	36 40	+ 25	15 6.0	30 0	+ 2
32 39.0	39 30	+ 19	16 29.5	20 0	+ 9
34 32.0	42 25	0	17 48.5	10 0	— 10
36 4.0	45 5	+ 6	19 6.7	0 0	— 3
38 46.0	49 20	+ 14	20 28.0	65 50 0	+ 2
39 57.0	50 50	+ 7	21 46.0	40 0	— 2
41 0.0	52 5	+ 6	23 4.0	30 0	+ 1
41 55.0	53 10	+ 2	24 23.0	20 0	+ 5
23 55 32.0	⊙ 74 3 55	— 8	2 26 32.0	⊙ 64 0 0	+ 13
57 10.0	4 10	— 1	27 47.5	63 50 0	+ 17
58 12.0	4 25	— 2	29 3.0	40 0	+ 9
59 16.0	4 25	— 7	30 15.5	30 0	— 3
0 0 2.0	4 40	— 3	31 34.0	20 0	+ 14
1 0.0	4 35	— 7	32 46.5	10 0	+ 4
2 4.0	4 30	— 11	34 1.5	0 0	+ 4
2 46.0	4 25	— 11	35 16.0	62 50 0	+ 7
3 26.0	4 30	— 7	36 28.5	40 0	— 15
5 45 23.0	⊙ 29 30 0	+ 1	5 50 48.0	⊙ 29 30 0	+ 9
47 4.0	10 0	+ 12	51 41.0	20 0	+ 14
47 56.0	0 0	+ 13	52 31.0	10 0	+ 3
48 46.0	28 50 0	+ 2	53 24.5	0 0	+ 12

Ifølge Tidssignal var den 12te August $9^h\ 0^m\ 1.^s3$ a. m. Chronometer Reid's Correction til Greenwich Middeltid $+\ 8^m\ 40.^s8$, der voxer med $0.^s97$ i 24^h. Herefter bliver Correctionen for Reid til Greenwich Middeltid ved den første Observation om Formiddagen $+\ 8^m\ 41.^s8$, ved den sidste af de correspondenende Højder om Eftermiddagen $+\ 8^m\ 42.^s0$ og ved Aftenobservationerne $+\ 8^m\ 42.^s1$.

Af Ligningerne findes den sandsynlige Fejl af en enkelt Højde

$$\delta = \pm\ 6.''3$$

og de sandsynligste Værdier for

On the 12th of August, $9^h\ 0^m\ 1.^s3$ a. m., the correction for the Reid chronometer to Greenwich mean time, as determined by the time-signals, was $+\ 8^m\ 40.^s8$, increasing $0.^s97$ in twenty-four hours. Hence, the Reid correction to Greenwich mean time for the first observation in the forenoon, will be $+\ 8^m\ 41.^s8$; for the last of the equal altitudes in the afternoon $+\ 8^m\ 42.^s0$; and for the evening observations $+\ 8^m\ 42.^s1$.

From the equations, the probable error of a single altitude is found to be

$$\delta = \pm\ 6.''3.$$

and the most probable values for

$$\Delta\varphi = +\ 3.''9 \pm 0.''74 \qquad \Delta\lambda = -\ 2.''4 \pm 3.''3 = -\ 0.^s19 \pm 0.^s22$$

Forudsættes en sandsynlig constant Fejl af $\pm\ 10''$ i de maalte Højder, vil denne i den beregnede Bredde give en sandsynlig Fejl af $\pm\ 10.''76$, og man faar saaledes som Resultat

$$\varphi = 67^0\ 17'\ 13.''9 \pm 10.''8$$

En constant Fejl af $10''$ i de maalte Højder giver en Fejl af $0.^s51$ i Længden. Den sandsynlige Fejl af den beregnede Længde kan derfor sættes lig

If we assume a probable constant error of $\pm\ 10''$ in the observed altitudes, this error will affect the computed latitude with a probable error of $\pm\ 10.''76$, and the final result will be

$$\varphi = 67^0\ 17'\ 13.''9 \pm 10.''8.$$

A constant error of $10''$ in the observed altitudes, entails an error of $0.^s51$ in longitude. The probable error of the computed longitude may accordingly be put at

$$\sqrt{(0.^s22)^2 + (0.^s51)^2 + D_1^2 + D_2^2 + D_3^2 + D_4^2 + D_5^2 + D_6^2 + D_7^2} = 0.^s63\ .$$

og man faar som Resultat

$$\begin{aligned}\lambda &= \ \ 0^h\ 57^m\ 39.^s4 \pm 0.^s63 \text{ E. Greenwich}\\ &= 14^0\ 24'\ 51'' \ \ \pm 9.''5 \quad ,, \quad -\end{aligned}$$

Ifølge de norske Kystkarter ligger mit Observationspunkt paa

Bredde $67^0\ 17'\ 15''$

Længde $14^0\ 25'\ 40'' = 0^h\ 57^m\ 42.^s7$ E. Greenwich.

Der er saaledes meget god Overensstemmelse i Bredden, medens min Bestemmelse lægger Bodø $3.^s3$ vestligere end Kartet, en Afstand, der svarer til 594 Meter.

and the final result will be

$$\begin{aligned}\lambda &= \ \ 0^h\ 57^m\ 39.^s4 \pm 0.^s63 \text{ E. Greenwich}\\ &= 14^0\ 24'\ 51'' \ \ \pm 9.''5 \quad ,, \quad -\end{aligned}$$

On the Norwegian coastal charts my point of observation is in

Latitude $67^0\ 17'\ 15''$

Longitude $14^0\ 25'\ 40'' = 0^h\ 57^m\ 42.^s7$ E. Greenwich.

Hence the agreement in latitude is quite satisfactory, whereas my determination, as compared with the chart, places Bodø $3.^s3$ farther west, a difference corresponding to 594 metres.

5. Røst.

Observationerne toges paa en større Holme, Skruholmen kaldet, den 26de Juni 1877. Ved Middagstider toges en Række Circummeridianhøjder og om Eftermiddagen en Række Højder i Nærheden af første Vertical. Ved den første Række benyttede jeg mit Duplexuhr, der sammen-

5. Røst.

The observations were made on a large holm, or islet, called Skruholmen, June the 26th 1877. At noon were taken a series of circum-meridian altitudes, and in the afternoon a series of altitudes near the prime vertical. For the first series, I used my duplex watch, which, imme-

lignedes, umiddelbart efter at Observationerne vare tagne, med Chronometer Frodsham, og hvis Angivelser paa Stedet reduceredes til dette. Ved Eftermiddagsobservationerne benyttede jeg Frodsham.

Indexfejlen fandtes ved Middag $= +2'\ 8.''8 \pm 5''$. 5 Obs.
om Efterm. $= +2\ \ 1.\ 7 \pm 2\ .$ 3 „

	8 a. m.	2 p. m.	8 a. m.
Barometer	750.^{mm}6	750.^{mm}6	749.^{mm}2
Temperatur	8.^{0}9	9.^{0}0	8.^{0}9

Efter Tidssignal, observeret i Bodø den 24de Juni, er for Frodshams Chronometer beregnet for Eftermiddagsobservationerne Correction til Greenwich Middeltid

$$-0^h\ 52^m\ 12.^s7.$$

Som foreløbige Værdier er sat

diately after taking the observations, was compared with the Frodsham chronometer, and its several indications reduced on the spot to those of the latter timepiece. For the afternoon-series, I used the Frodsham.

Index-error at Noon $= +2'\ 8.''8 \pm 5''$. 5 Observations.
— after Noon $= +2\ \ 1.\ 7 \pm 2\ .$ 3 —

	8 a. m.	2 p. m.	8 a. m.
Barometer	750.^{mm}6	750.^{mm}6	749.^{mm}2
Temperature	8.^{0}9	9.^{0}0	8.^{0}9

The Frodsham correction to Greenwich mean time, as determined from the time-signals at Bodø on the 24th of June, was found to be

$$-0^h\ 52^m\ 12.^s7.$$

As approximate values,

$$\varphi_0 = 67^0\ 29'\ 50'' \text{ and } \lambda_0 = 0^h\ 48^m\ 29.^s1 \text{ E. Greenwich.}$$

1877. Juni *(June)* 26.

Chron. Frodsham.	2 h′	Δ
$0^h\ 13^m\ \ 6.^s6$	☉ $92^0\ 13'\ 45''$	$-\ 7''$
14 6. 6	13 20	— 6
15 6. 6	12 50	— 3
19 6. 6	10 0	— 3
20 36. 6	8 30	— 9
21 58. 6	7 30	+ 4
22 36. 6	6 30	— 6
24 30. 6	☉ 91 1 35	+ 7
25 28. 6	0 10	— 2
26 38. 6	90 59 5	+ 14
27 46. 6	57 30	+ 14
29 8. 6	55 30	+ 14
29 51. 6	54 0	+ 1
30 54. 6	51 50	— 16

Chron. Frodsham.	2 h′	Δ
$4^h\ 46^m\ 31.^s7$	☉ $57^0\ 40'\ 0''$	$-\ 14''$
47 26. 7	30 0	— 2
48 19. 0	20 0	+ 4
49 12. 5	10 0	— 2
50 6. 5	0 0	+ 4
50 58. 7	56 50 0	+ 1
51 51. 0	40 0	— 2
52 43. 8	30 0	— 3
53 35. 5	20 0	— 8
55 37. 0	☉ 57 0 0	+ 4
56 30. 0	56 50 0	+ 3
57 22. 0	40 0	— 1
58 15. 8	30 0	+ 6
59 8. 5	20 0	+ 8
5 0 0. 2	10 0	+ 1
0 54. 5	0 0	+ 12
1 45. 5	55 50 0	— 3
2 38. 8	40 0	+ 7

Differentserne Δ mellem de observerede og beregnede Højder ere tagne efterat den benyttede Solradius er formindsket med 7.″2 forat tilfredsstille Observationerne af begge Solrender.

Efter de mindste Kvadraters Methode har Hr. Åstrand fundet

The differences, Δ, between the observed and the computed altitudes, were found after diminishing the assumed semidiameter of the sun by 7.″2, to satisfy the observations of both limbs.

By the method of the least squares, Mr. Åstrand found

$$\delta = \pm 5.''1;\quad \Delta\varphi = -2.''6 \pm 1.''4;\quad \Delta\lambda = +0.^s69 \pm 0.^s21.$$

Forudsættes en sandsynlig constant Fejl af $\pm 10''$, bliver dens Virkning paa den beregnede Bredde $\pm 9.''9$, og Resultatet bliver

$$\varphi = 67^0\ 29'\ 47.''4 \pm 10.''0.$$

Assuming a probable constant error of $\pm 10''$, the effect on the computed latitude will be $\pm 9.''9$, and the result therefore

$$\varphi = 67^0\ 29'\ 47.''4 \pm 10.''0.$$

En constant Fejl af $10''$ i de maalte Højder giver en Fejl af $1.^s66$ i den beregnede Længde. Sættes den sandsynlige Fejl af den beregnede Længde lig

A constant error of $10''$ in the observed altitudes, entails an error of $1.^s66$ in the computed longitude. Putting the probable error of the computed longitude at

$$\sqrt{(0.^s21)^2 + (1.^s66)^2 + D_1^2 + D_2^2 + D_3^2 + D_4^2 + D_5^2 + D_6^2 + D_7^2} = \pm 1.^s72$$

faaes som Resultat

the result will be

$$\lambda = 0^h\ 48^m\ 29.^s8 \pm 1.^s72 = 12^\circ\ 7'\ 27'' \pm 25.''8 \text{ E. Greenwich.}$$

Efter de norske Kystkarter ligger Skruholmen paa
Bredde $67^\circ\ 29'\ 48''$
Længde $12^\circ\ 6'\ 36'' = 0^h\ 48^m\ 26.^s4$ E. Greenwich.

Der er saaledes god Overensstemmelse i Bredden, medens min Bestemmelse lægger Røst $51''$ eller $3.^s4$ østligere end Kartet, en Afstand, der svarer til 602 Meter.

On the Norwegian coastal charts, Skruholmen is in
Latitude $67^\circ\ 29'\ 48''$
Longitude $12^\circ\ 6'\ 36'' = 0^h\ 48^m\ 26.^s4$ E. Greenwich.

Hence the agreement in latitude is quite satisfactory, whereas my determination of longitude, as compared with the chart, places Røst $51''$, or $3.^s4$, farther east, a difference corresponding to 602 metres.

6. Hammerfest.

Observationerne gjordes om Eftermiddagen den 9de Juli og om Morgenen den 10de Juli 1878 paa Fuglenes i Meridian-Støttens Meridian, omtrent 5 Meter i Syd for samme. Polhøjden af Meridian-Støtten, der danner det nordlige Endepunkt af den Russisk-Svensk-Norske Gradmaaling, er bestemt af Professor Lindhagen til $70^\circ\ 40'\ 11.''3$. Omstændighederne vare meget gunstige, Luften klar og rolig.

6. Hammerfest.

The observations were taken in the afternoon of the 9th of July and on the morning of the 10th, 1878, at Fuglenes, in the meridian of the "Meridian-Column," about 5 metres farther south. The latitude of the Column, which constitutes the northern terminal point of the Russian-Swedish-Norwegian arc of meridian, has been determined by Professor Lindhagen at $70^\circ\ 40'\ 11.''3$. Circumstances were remarkably favourable, the atmosphere both clear and still.

Den 9de Juli Eft. fandtes Indexfejlen (*Index-error p. m.*) $+ 2'\ 7.''2 \pm 2.''2$. 6 Obs.
„ 10de „ Form. — — (— *a. m.*) $+ 2\ \ 3.\ 3 \pm 3.\ 1$. 3 „

Som Observationsuhr benyttede jeg mit Lommechronometer.

For these observations, I used my pocket-chronometer.

Chron. Reid Juli 9	*(Reid's Chronometer)*	$2^h\ 21^m\ 30.^s0$	$6^h\ 25^m\ 0.^s0$	$17^h\ 7^m\ 0.^s0$	$19^h\ 23^m\ 0.^s0$	$20^h\ 3^m\ 30.^s0$
Lommechron. „ 9	*(Pocket-chronometer)*	3 15 14.0	7 18 42.9	18 0 41.7	20 16 41.1	20 57 10.9
Corr. t. Reid	*(Corr. to Reid)*	— 53 44.0	— 53 42.9	— 53 41.7	— 53 41.1	— 53 40.9

Juli 9 Eft. Barom. $760.^{mm}0$ Temp. 8°
„ 10 Morgen — $759.^{mm}3$ — 11°

Paa Telegrafcontoret i Hammerfest observerede jeg den 10de Juli

Lommechronometer	$8^h\ 38^m\ 22.^s0$	
Corrigeret Tidssignal	8 0 1. 2	Greenwich M. T.
Corr. af Lommechron.	— 38 20. 8	til Gr. M. T.
„ „ —	53 41. 0	„ Reid.
Corr. for Reid	+ 15 20. 2	til Greenwich M. T.

July 9 p. m. Barom. $760.^{mm}0$ Temp. 8°
„ 10 a. m. — $759.^{mm}3$ — 11°

At the telegraph-office in Hammerfest, I observed on the 10th of July

Pocket-chronometer	$8^h\ 38^m\ 22.^s0$	
Corrected Time-signals	8 0 1. 2	Greenwich M. T.
Corr. for Pocket-chron.	— 38 20. 8	to Gr. M. T.
— —	53 41. 0	to the Reid chron.
Corr. for the Reid	+ 15 20. 2	to Greenwich M. T.

Med Polhøjden 70° 40′ 11.″2 beregnede Hr. Åstrand Længden saaledes:

With the latitude 70° 40′ 11.″2. Mr. Åstrand computed the longitude as follows: —

Af Observationerne Juli 9 Eft. (*From the observations July 9th p. m.*)	☉	$1^h\ 34^m\ 44.^s5$	$1^h\ 34^m\ 43.^s95$
	☉	1 34 43.4	
Juli 10 Morg. (— — *July 10th a. m.*)	☉	1 34 40.7	1 34 40.60
	☉	1 34 40.1	

For at bringe Eftermiddagsobservationerne af begge Solrender i Overensstemmelse, trænger den benyttede Solradius en Tilvæxt af 2.″7. For Morgenobservationernes Vedkommende trænges en Tilvæxt af 1.″4.

De to Observationsrækker give, som man ser, merkelig forskjellige Værdier af Længden. Sammenstillingen af de af begge udledede Uhrcorrectioner giver for Normalchronometret Reid en Acceleration af flere Secunder i Mellemtiden, 14 Timer, medens dette Chronometer stadig, ifølge Tidssignalerne, har en Retardation af henimod et Secund i Døgnet. De ovenfor anførte Uhrsammenligninger vise ogsaa, at Lommechronometret den hele Tid retarderer i Forhold til Reid, men langsommere i Løbet af Natten, medens det modsatte maatte være Tilfældet, om Reid i Løbet af Natten havde accelereret. Jeg tør derfor ikke lægge Skylden for Uoverensstemmelsen mellem de beregnede Resultater af Eftermiddags- og Morgen-Observationerne paa Chronometret. Da Højderne ikke ere langt fra at være corresponderende, antager jeg Tilstedeværelsen af en constant Fejl i alle maalte Højder, og har efter de mindste Kvadraters Methode søgt den sandsynligste Værdi af denne samtidig med den sandsynligste Værdi af Længden. Til denne Beregning kunde jeg benytte de Beregninger, som Hr. Åstrand, efter min Opfordring, havde gjort, uden at antage nogen constant Fejl. Som foreløbig Værdi for Længden satte jeg $\lambda_0 = 1^h\ 34^m\ 41.^s6$ og indførte de ovenfor nævnte Correctioner for den apparente Solradius.

To satisfy the p. m. observations of both solar limbs, will require an increase in the semidiameter of the sun of 2.″7. For the a. m. observations, is needed an increase of 1.″4.

The two series of observations give remarkably different values for the longitude. A comparison of the chronometer-errors deduced from both indicates for the chief chronometer — the Reid — an acceleration of several seconds during the interval (14 hours), whereas that chronometer, according to the time-signals, invariably exhibited a retardation of one second in twenty-four hours. Moreover, the comparisons of the respective timekeepers show the pocket-chronometer, as compared with the Reid, to have been steadily gaining, — more slowly however in the course of the night; whereas the reverse must have been the case had the Reid gained in the night. Hence, I cannot ascribe this want of agreement between the computed results of the p. m. and a. m. observations to the chronometer. The altitudes being very nearly equal, I have assumed the presence of a constant error in all the observed altitudes, and by the method of the least squares sought to find its most probable value, together with the most probable value of the longitude. For this computation, I could apply the greater part of the calculations kindly made at my request by Mr. Åstrand, who had not assumed any constant error. As a preliminary value for the longitude, I put $\lambda_0 = 1^h\ 34^m\ 41.^s6$, introducing also the above-mentioned corrections for the sun's apparent semidiameter.

1878. Juli (*July*) 9.

Lommechronometer. (*Pocket-Chronometer.*)	2 h′	$\varDelta$
4^h 15^m $26.^s0$	☉ 50° 20′	+ 4″
16 27.6	10	+ 8
17 27.1	0	+ 3
18 26.0	49 50	− 5
19 26.4	40	− 6
20 27.6	30	− 3
21 29.2	20	+ 1
22 28.8	10	− 3
23 29.6	0	− 4
4. 26 52.0	☉ 49 30	+ 5
27 51.2	20	− 0
28 51.2	10	− 4
29 51.2	0	− 7
30 52.8	48 50	− 2
33 54.4	20	− 0
34 56.4	10	+ 8
35 56.0	0	+ 6
36 56.4	47 50	+ 3
37 55.2	40	− 3

Lommechronometer. (*Pocket-Chronometer.*)	2 h′	$\varDelta$
18^h 50^m $48.^s4$	☉ 59° 10′	− 14″
51 50.4	20	− 10
52 54.4	30	− 7
53 56.4	40	− 3
54 59.6	50	− 4
56 2.4	60 0	+ 1
57 8.4	10	− 10
58 10.4	20	− 1
59 13.2	30	+ 4
19 0 18.0	40	− 1
1 21.4	50	+ 4
2 23.6	61 0	+ 13
3 28.8	10	+ 8
4 34.0	20	+ 6
19 7 5.6	☉ 60 40	− 2
8 9.6	50	+ 2
9 13.2	61 0	+ 8
10 20.4	10	− 2
11 23.6	20	+ 7
12 30.4	30	+ 1
14 42.4	50	− 4
15 45.2	62 0	+ 10
16 52.8	10	+ 2
18 0.0	20	− 4
19 5.2	30	+ 10
20 12.8	40	− 5
21 20.0	50	− 9
22 24.8	63 0	+ 0

Beregningen giver $\delta = \pm 4.''0$.
$\varDelta\lambda = + 11.''5 \pm 1.''8 = + 0.^s77 \pm 0.^s12$; Const. Corr. paa Højderne $= + 8.''0 \pm 0.''6$ og som Resultat, naar den sandsynlige Fejl af den beregnede Længde sættes

The computation gives $\delta = \pm 4.''0$.
$\varDelta\lambda = + 11.''5 \pm 1.''8 = + 0.^s77 \pm 0.^s12$; const. corr. in the altitudes $= + 8.''0 \pm 0.''6$, and as result, the probable error of the computed longitude being put

$$= \sqrt{(0.^s12)^2 + D_1^2 + D_2^2 + D_3^2 + D_4^2 + D_5^2 + D_6^2 + D_7^2} = \pm 0.^s41$$

$$\lambda = 1^h\ 34^m\ 41.^s7 \pm 0.^s41 = 23°\ 40'\ 25.''8 \pm 6.''1 \text{ E. Greenwich.}$$

Den sandsynlige Fejl svarer til en Afstand af 74 Meter.

Efter Professor Fearnleys Beregning af Gradmaalingen, med Udgangspunkt Dorpat, skulde Længden af Meridianstøtten paa Fuglenes være 23° 40′ 0.″9 E Gr. Efter den af Svenskerne (Meddelelse fra Prof. Rosén til den geografiske Opmaaling) senere udførte telegrafiske Længdebestemmelse af Kokkomäki ($\varphi = 65°\ 49'\ 16''$) — Stockholm, bliver Længden af Meridianstøtten paa Fuglenes

23° 40′ 22.″1 = 1^h 34^m $41.^s5$ E. Gr.

fra hvilken Bestemmelse min afviger kun 3.″7 eller $0.^s25$, der svarer til en Afstand af 39 Meter.

The probable error corresponds to a distance of 64 metres.

According to Professor Fearnley's computation from the triangulation, — starting from Dorpat, — the longitude of the Meridian Column at Fuglenes should be 23° 40′ 0.″9 E. Gr. Meanwhile, the telegraphic determination of longitude for Kokkomäki ($\varphi = 65°\ 49'\ 16''$) — Stockholm, subsequently performed by Swedish astronomers (communication from Professor Rosén to the Geographical Survey), places the Meridian Column at Fuglenes in longitude

23° 40′ 22.″1 = 1^h 34^m $41.^s5$ E. Greenwich

from which result my determination differs only 3.″7, or $0.^s25$, corresponding to 39 metres.

De norske Kystkarter give for samme Punkt

$$\varphi = 70^\circ\ 40'\ 25'' \text{ og } \lambda = 23^\circ\ 39'\ 54''$$

altsaa Bredden 14″ for stor og Længden c. 30″ eller 2ˢ for liden (310 Meter).

The Norwegian coastal charts give for the point in question

$$\varphi = 70^\circ\ 40'\ 25'' \text{ and } \lambda = 23^\circ\ 39'\ 54''$$

the latitude, therefore, 14″ too far north, and the longitude about 30″, or 2ˢ (310 metres), not far enough east.

7. Vardø.

Observationerne gjordes den 26de Juni 1878 omkring Middag paa et Punkt, der, ifølge Observationer med Theodolithen, ligger 175 Meter Nord og 51 Meter Vest for Midtpunktet af Fæstningen Vardohus. Luften, der i Begyndelsen var klar, blev efter Middag taaget, saa at den sidste Række Højder maatte tages med svage Blændglas foran begge Spejle, og tilsidst maatte Observationerne afbrydes, da det skyede ganske over. Jeg opnaaede saaledes ikke at faa lige mange Højder af hver Solrand, og Indexfejlens Bestemmelse blev mangelfuld. I Middel af 4 Bestemmelser fandtes Indexfejlen $+ 2'\ 13'' \pm 3''$.

Som Observationsuhr benyttede jeg mit Lommechronometer.

Reid	$18^h\ 43^m\ 0.^s0$
Lommechron.	19 37 52. 8
Corr. t. Reid	— 54 52. 8

Lommechronometret taber i Forhold til Reid 0.ˢ23 pr. Time.

Efter de meteorologiske Observationer i Vardø var:

Juli 26	8 a. m.	Barom.	765.ᵐᵐ9	Temp. C.	6.°0
— „	2 p. m.	—	765. 9	— „	9. 4

7. Vardø.

The observations were taken on the 26th of June, 1878, about noon, from a point which, as determined with the theodolite, lies 175 metres north and 51 metres west of the centre of Vardohus fortress. The atmosphere, clear at first, soon got hazy, so that the last series of altitudes had to be taken with light-coloured glasses, and ere long the observations had to be broken off, the sky becoming quite overcast. Hence, I did not succeed in getting an equal number of altitudes of each solar limb; and the index-error was not very well determined. As a mean of 4 observations, the index-error was found to be $+ 2'\ 13'' \pm 3''$.

On this occasion, I observed with my pocket-chronometer.

Reid	$18^h\ 43^m\ 0.^s0$
Pocket-chron.	19 37 52. 8
Corr. to the Reid	— 54 52. 8

The pocket-chronometer was losing hourly 0ˢ.23 more than the Reid.

The meteorological observations at Vardø gave the following results: —

July 26	8 a. m.	Barom.	765.ᵐᵐ9	Temp. C.	7.°0
— „	2 p. m.	—	765. 9	— „	9. 4

1878. Juni (*June*) 25—26.

Lommechron. (*Pocket-Chronometer.*)	2 h′	Δ
21h 31m 36.s8	⊙ 83° 30′ 0″	− 0″
33 8.0	35 0	− 10
34 30.8	40 0	− 2
35 58.8	45 0	+ 1
37 30.0	50 0	+ 1
39 5.2	55 0	− 1
40 41.2	84 0 0	0
42 17.6	5 0	+ 4
44 5.6	10 0	− 5
52 36.4	⊙ 85 36 10	+ 4
53 45.6	38 35	− 7
54 52.4	41 25	− 1
55 58.4	43 50	− 5
57 17.2	46 30	− 13
58 27.6	49 10	− 4
59 53.6	52 30	+ 0
22 1 44.4	56 0	− 6
2 57.6	58 10	− 12
4 51.2	86 2 0	− 11
5 43.6	3 35	− 1
7 17.6	6 5	− 5
8 18.8	7 45	− 6
9 59.6	10 50	+ 7
11 32.4	13 10	+ 9
12 40.0	14 30	+ 2
13 37.6	15 40	− 2
14 48.8	17 5	− 5
15 36.4	18 0	− 7
17 0.8	19 50	− 1
17 58.8	21 0	+ 1

Lommechron. (*Pocket-Chronometer.*)	2 h′	Δ
22h 18m 54.s4	⊙ 86° 22′ 0″	+ 2″
19 55.6	23 5	+ 8
20 46.0	24 30	+ 22
22 58.0	25 55	+ 7
24 16.8	26 40	− 1
24 59.2	27 20	+ 2
25 55.8	27 45	− 3
26 44.8	28 35	+ 7
27 45.6	28 40	− 7
28 32.8	29 20	− 0
30 27.2	30 0	+ 9
31 32.0	31 0	+ 12
32 31.2	31 10	+ 8
22 37 17.2	⊙ 85 28 20	− 6
38 29.6	28 35	+ 2
39 28.0	28 35	+ 4
40 37.2	28 35	+ 9
41 30.8	28 5	− 1
42 45.2	27 40	− 6
43 50.4	27 20	− 3
45 24.0	26 45	− 4
47 34.8	26 0	+ 5
49 32.4	25 0	+ 11
23 43 6.0	⊙ 84 35 0	− 2
44 34.0	30 0	− 4
45 55.2	25 0	− 13
47 20.4	20 0	+ 0
48 50.0	15 0	+ 11
50 1.6	10 0	+ 5
51 14.0	5 0	− 5

I Betingelsesligningerne har Hr. Åstrand indført en Correction ($\Delta\,\varrho$) for den benyttede Solradius. Som tilnærmede Værdier er antaget $\varphi_0 = 70^\circ\ 22'\ 28.''3$ og $\lambda_0 = 2^h\ 4^m\ 28.^s8$, og Reids Correction til Greenwich Middeltid ved Observationernes Begyndelse sat til $+\ 15^m\ 8.^s1$.

Af Ligningerne findes:

In the equations of condition, Mr. Åstrand introduced a correction ($\Delta\,\varrho$) for the assumed semidiameter of the sun. As approximate values, he put $\varphi_0 = 70^\circ\ 22'\ 28.''3$ and $\lambda_0 = 2^h\ 4^m\ 28.^s8$, and the Reid correction to Greenwich mean time at the beginning of the observations $= +\ 15^m\ 8.^s1$.

From the equations, he found

$$\delta = \pm\ 4.''6;\ \Delta\,\varrho = +\ 5.''9 \pm 0.''66$$
$$\Delta\,\varphi = -\ 4.''3 \pm 0.''7;\ \Delta\,\lambda = +\ 34.''4 \pm 9.''4 = +\ 2.^s29 \pm 0.^s63.$$

Antages en sandsynlig constant Fejl i de maalte Højder af $\pm\ 10''$, saa er dennes Indflydelse paa den beregnede Bredde $\pm\ 11.''4$, og paa den beregnede Længde $\pm\ 0.^s39$. Resultatet bliver:

Assuming a probable constant error in the observed altitudes of $\pm\ 10''$, its effect on the computed latitude will be $\pm\ 11.''4$, and on the computed longitude $\pm\ 0.^s39$; as result we get

$$\varphi = 70^\circ\ 22'\ 24.''0 \pm 11.''4$$
$$\lambda = 31^\circ\ \ 7'\ 46.''4 \pm 12.''6 = 2^h\ 4^m\ 31.^s1 \pm 0.^s84 \text{ E. Greenwich.}$$

Reduceres til Fæstningens Midte faaes: Vardøhus

Reduced to the centre of the fortress, we get for Vardøhus —

$$\varphi = 70^\circ\ 22'\ 18.''4 \pm 11.''4$$
$$\lambda = 31^\circ\ \ 7'\ 51.''3 \pm 12.''6 = 2^h\ 4^m\ 31.^s4 \pm 0.^s84 \text{ E. Greenwich.}$$

Efter de norske Kystkarter ligger Vardohus paa:
Bredden 70° 22′ 5″
Længden 31° 7′ 35″ = $2^h\ 4^m\ 30.^s3$ E. Greenwich.

Efter en senere fundet Correction for en Regnefejl skulde imidlertid Punkterne østenfor Nordkap ligge c. 22″ østligere end i Kartet, altsaa Vardohus paa Længden 31° 7′ 57″ = $2^h\ 4^m\ 31.^s8$, hvilken Værdi kun er 6″ eller $0.^s4$ større end den af mig fundne.

On the Norwegian coastal charts, Vardohus is in
Latitude 70° 22′ 5″
Longitude 31° 7′ 35″ = $2^h\ 4^m\ 30.^s3$ E. Greenwich.

Meanwhile, the points east of the North Cape should, according to an error of calculation subsequently discovered, lie about 22″ farther east than on the chart. Vardohus therefore in longitude 31° 7′ 57″ = $2^h\ 4^m\ 31.^s8$; and this value exceeds my determination by only 6″, or $0.^s4$.

Sammenstilles de af mig fundne Længder med de paa de norske Kystkarter udmaalte, faar man følgende Oversigt:

A comparison between my determinations of longitude and those on the respective Norwegian charts gives the following results: —

	Astron. telegr. Længde. (Longitude Astr. Telgh.)	Kartets Længde. (Long. on Chart.)	Forskjel. (Difference.)
Namsos . . .	11° 31′ 33″ ± 7.″4	11° 30′ 45″	45″ = $3.^s0$
Bodø	14 24 51 ± 9. 5	14 25 40	— 49 = — 3. 3
Røst	12 7 27 ± 25. 8	12 6 36	59 = 3. 4
Hammerfest . .	23 40 26 ± 6. 1	23 39 54	32 = 2. 1
Vardø	31 7 51 ± 12. 6	31 7 35	16 = 1. 1

Med Undtagelse af Bodø ere Kartets Længder mindre østlige end mine. Forskjellen er imidlertid kun en Brøkdel af et Minut, i Storcirkel kun en Brøkdel af et halvt til et Trediedels Minut, og Tilstrækkeligheden af Nøjagtigheden af Karternes Længde for Skibsfarten antages saaledes godtgjort. Karternes Bredder synes gjennemgaaende nøjagtige, saavidt ovenstaaende Iagttagelser kunne tjene til deres Verification.

Saving that of Bodø, the longitudes on the chart are none of them so far east as mine. Meanwhile, the difference does not amount to more than a fraction of a minute, and in arc of great circle it is only a fraction of half to one-third of a minute; hence, the accuracy of the longitudes on the charts may be regarded as sufficient for all practical purposes of navigation. The latitudes on the charts would appear to be generally correct, so far as the results set forth above can serve for their verification.

8. Advent Baj.

Paa Odden, ved den vestre Bred af Indløbet til Advent Baj, der gaar i sydostlig Retning ind fra den indre Del af Isfjorden paa Spidsbergens Vestkyst, tog jeg den 20de August 1878 to Rækker Solhøjder til Bestemmelse af Bredden og Længden af det Punkt, der var Udgangspunktet for Iagttagelserne til Constructionen af det Kart, som Capt. Wille optog over Bajen med Omgivelser.

Omstændighederne vare ikke meget gunstige. Luften var tildels meget taaget, saaat Blændglassene ofte maatte vexles, ja kunde stundom endog undværes. En Følge af

8. Advent Bay.

On the tongue of land jutting out from the western shore of the entrance to Advent Bay, which extends in a south-easterly direction from the inner part of Ice Sound on the west coast of Spitsbergen, I took on the 20th of August, 1878, two series of solar altitudes, to determine the latitude and longitude of the point at which were commenced the observations for the survey made by Capt. Wille of the Bay and its environs.

Circumstances were anything but favourable, the atmosphere being so hazy at intervals that the coloured glasses had to be frequently changed, nay could now and again

disse Omstændigheder var det desværre, at jeg ikke kunde faa nogen brugbar Bestemmelse af Indexfejlen. Denne har jeg senere søgt at finde saaledes:

be dispensed with. As a consequence of these atmospheric conditions, I failed to obtain a trustworthy determination of the index-error. This I sought subsequently to find in the following manner: —

I Hammerfest den	9de Juli 1878	ved en Temperatur af	+ 8° C.	var Indexfejlen *(Index-error)*	+ 2′ 7″
„ —	„ 10de „	— „ „ —	„ + 10 „ „	— —	+ 2 3
„ Christiania	„ 11te Decb.	— „ „ —	„ — 3 „ „	— —	+ 2 27

Under Observationerne i Advent Baj var Luftens Temperatur + 3°, hvortil, efter grafisk Interpolation, svarer en Indexfejl af + 2′ 16″, der er benyttet til Beregningen af Højderne.

During the observations taken at Advent Bay, the temperature of the atmosphere was + 3°, to which, as found from diagrammatic interpolation, corresponds an index-error of + 2′ 16″, that assumed for computing the altitudes.

Den benyttede Solradius er den, som er udledet af Sammenligning mellem Observationerne af øvre og nedre Solrand.

The apparent semidiameter of the sun taken for the computation, is that determined from a comparison of the observations of the upper and lower limbs.

Observationsuhr var mit Lommechronometer, der før og efter sammenlignedes med Hovedchronometret Reid ombord.

On this occasion, I observed with my pocket-chronometer, which, before and after the observations, was compared on board with the chief timekeeper (Reid).

Reid	$19^h\ 4^m\ 0.^s0$	$0^h\ 55^m\ 0.^s0$
Lommechron. *(Pocket-chron.)*	19 53 58.6	1 44 57.2
Corr. t. Reid *(Corr. to Reid)*	— 49 58.6	— 49 57.2

Efter de timevise meteorologiske Iagttagelser ombord var

According to the hourly meteorological observations on board, the temperature and barometric pressure were as follows: —

ved Morgenobs. Kl. 9 a. m. *(9 a. m.)*	Barom. = 755.mm1	Temp. = 3.°0
„ Efterm.obs. „ 1 p. m. *(1 p. m.)*	— 755. 0	— 2. 6

1878. August *(August)* 19—20.

Lommechron. *(Pocket-Chronometer)*	2 h′	Δ
$20^h\ 35^m\ 59.^s6$	⊙ 40° 50′ 0″	— 7″
37 13.0	55 40	— 1
39 18.4	41 4 55	0
44 43.2	⊙ 42 31 40	+ 11
50 37.2	42 56 10	— 2
55 52.0	43 17 50	+ 1
57 20.0	43 23 45	— 1
59 43.2	43 33 15	— 4
21 6 32.0	⊙ 42 57 10	+ 3
7 37.6	43 1 20	+ 3

Lommechron. *(Pocket-Chronometer)*	2 h′	Δ
$0^h\ 29^m\ 55^s$	⊙ 47° 8′ 50″	+ 1″
33 50	⊙ 48 5 5	— 7
34 40	48 3 50	— 4
35 40	⊙ 46 59 10	— 5
37 28	46 56 10	+ 1
41 55	⊙ 47 51 5	+ 5

Ved de mindste Kvadraters Methode har Hr. Åstrand fundet, idet der sættes $\varphi_0 = 78°\ 14'\ 48''$, $\lambda_0 = 1^h\ 2^m\ 15.^s9$, og Reids Correction til Greenwich Middeltid ved Formiddagsobservationerne + $16^m\ 0.^s0$,

By the method of the least squares, putting $\varphi_0 = 78°\ 14'\ 48''$, $\lambda_0 = 1^h\ 2^m\ 15.^s9$, and the Reid correction to Greenwich mean time for the a. m. observations = + $16^m\ 0.^s0$, Mr. Åstrand found

$$\vartheta = \mp 3.''3$$

$$\Delta\varphi = +\ 0.''4 \pm 1.''1, \quad \Delta\lambda = +\ 0.''3 \pm 7.''8 = +\ 0.^s02 \pm 0.^s52.$$

En sandsynlig constant Fejl af 10″ i alle Højder bevirker en Fejl af 11.″6 i den beregnede Bredde og af 0.^{s}90 i den beregnede Længde. Resultatet bliver saaledes

$\varphi = 78^\circ\ 14'\ 48.''4 \pm 11.''6$
$\lambda = 15^\circ\ 33'\ 58.''5 \pm 16.\ 7 = 1^h\ 2^m\ 15.^s9 \pm 1.^s11$

I Kgl. Svenska Vetenskaps-Akademiens Handlingar, 13de Bind No. 9, findes en Afhandling af Dr. Aug. Wijkander: "Astronomiska Observationer under den Svenska Arktiska Expeditionen 1872—73. I. Tids- och Orts-Bestämningar." I Fortegnelsen over Bredder og Længder findes her, Side 54, ogsaa Punkter ved Advent Baj, nemlig "Rysstugen" og "Mynningen af elfven", begge bestemte efter Observationer af Prof. Nordenskiöld.

Ved Hjelp af det af Capt. Wille tegnede Kart over Advent Baj kan jeg med Lethed reducere mine Bestemmelser for Odden til de to nævnte Punkter. Jeg finder

"Odden"	Br. 78° 14′ 48.″4	L. $1^h\ 2^m\ 15.^s92$
Red. til "Russestuen"	— 1. 9	— 2. 31
Russestuen	78 14 46. 5	1 2 13. 61
do. efter Svenskerne	78 15 2.	1 2 31. 5
Forskjel	— 15.″5	— 17^s 9.
Red. t. "Mund. af Elven"	29.″5	— $2.^s85$
Mund. af Elven	78° 14′ 18. 9	$1^h\ 2^m$ 13. 07
do. efter Sv. Exp.	78 14 11.	1 2 31. 0
Forskjel	+ 7.″9	— $17.^s$ 9

Medens Bredderne stemme, i Middel, indenfor den af den sandsynlige Fejl betegnede Grændse, ere de Svenske Expeditioners Længder c. 18^s mere ostlige end mine. Da Længden af Punkterne ved Advent Bay af Svenskerne er henført til Længden af Sabine's Observatorium paa Indre Norskoen, og der — som af Dr. Wijkander i nævnte Afhandling Side 48—49 fremhævet, — er flere Grunde tilstede, der gjøre det sandsynligt, at Sabine's Længde er for stor ostlig, 16 til 30 Tidssecunder, saa tør jeg anse den af mig fundne Længde for Advent Baj for at være nær den rigtige, og de 18 Tidssecunders Forskjel fra de Svenske Expeditioners som Correction til Sabines Længde af Observatoriet paa Indre Norskoen.

A probable constant error of 10″ in all the altitudes, will entail an error of 11.″6 in the computed latitudes and of 0.^{s}90 in the computed longitude. The result is thus —

$\varphi = 78^\circ\ 14'\ 48.''4 \pm 11.''6$
$\lambda = 15^\circ\ 33'\ 58.''5 \pm 16.''7 = 1^h\ 2^m\ 15.^s9 \pm 1.^s11$

In Kgl. Svenska Vetenskaps-Akademiens Handlingar, Vol. 13, No. 9, Dr. Aug. Wijkander has furnished a paper entitled "Astronomiska Observationer under den Svenska Arktiska Expeditionen 1872—1873. I. Tids- och Orts-Bestämningar." The List of Latitudes and Longitudes, p. 54, includes those of two points at Advent Bay, viz. "Rysstugen" and "Mynningen of elfven," both determined from the observations of Professor Nordenskiöld.

By referring to Capt. Wille's map of Advent Bay, I could easily reduce my determinations for the tongue of land to those of the Swedish observer for the two points. The results were as follows: —

Tongue of land	Lat 78° 14′ 48.″4	Long. $1^h\ 2^m\ 15.^s92$
Red. to "Russian Hut" —	— 1. 9	— 2. 31
Russian Hut	78 14 46. 5	1 2 13. 61
Do. Swed. Observ.	78 15 2	1 2 31. 5
Difference	— 15.″5	— $17.^s$ 9
Red. to "Mouth of River"	29.″5	$2.^s85$
Mouth of River	78° 14′ 18.″9	$1^h\ 2^m\ 13.^s07$
Do. Swed. Observ.	78 14 11	1 2 31. 0
Difference	+ 7.″9	— $17.^s$ 9

Whilst the mean of the latitudes agrees within the limits of the probable error, the longitudes determined on the Swedish Expeditions are about 18^s farther east than mine. The longitude of the points at Advent Bay being referred by the Swedish observers to the longitude of Sabine's Observatory on "Inner Norway Island," and several reasons — as adduced by Dr. Wijkander in the abovementioned paper, pp. 48, 49, — rendering it highly probable that Sabine's longitude is too far east, — from 16 to 30 seconds in time, — I may regard my longitude for Advent Bay as very nearly correct, and the 18 seconds in time by which it differs from that determined on the Swedish Expeditions, as a correction for Sabine's longitude of the Observatory on Inner Norway Island.

9. Jan Mayen.

Den 30te Juli 1877, om Eftermiddagen, da "Vøringen" befandt sig i Mary Muss Bugten paa Vestsiden af Jan Mayen, brød i korte Stunder Solen igjennem Taagen, og der observeredes to Solhøjder, netop som vi lettede fra Ankerpladsen.

9. Jan Mayen.

In the afternoon of the 30th of July, 1877, — the "Vøringen" lying at anchor in Mary Muss Bay on the west coast of Jan Mayen, — the sun broke at intervals through the mist, and two solar altitudes were taken, just as we were getting under weigh.

Den følgende Dag, den 31te Juli, laa Expeditionen til Ankers i den store Rækved-Bugt paa Jan Mayens Østside. Da Søgangen hindrede os fra at komme i Land, toges fra Skibsborde en Række Solhøjder, med forskjellige Sextanter, dels af Capt. Wille, dels af mig. Omstændighederne vare ikke gunstige. Skyer og Taage tog jevnlig Solen eller Horizonten bort.

Den 1ste August var Vejret noget gunstigere, og der observeredes om Formiddagen en Del Solhøjder fra samme Ankerplads, forend vi lettede.

I den nedenstaaende Tabel betegner G Capt. Grieg og M Mohn; E betegner den Expeditionen tilhorende Sextant og S en Skibet tilhorende Sextant.

Hver Iagttager bestemte sin Indexfejl. Jeg fandt den for Troughtons Sextant den 31te Juli ved Solen $+ 1' 38''$ og ved Horizonten $+ 1' 35''$. Benyttet er den forste Værdi.

De fleste Observationer gjordes fra Hyttedækket. Øjets Højde regnedes her til 18 norske Fod eller 5.6 Meter.

I Beregningen er benyttet Solradien efter Nautical Almanac. Som det vil sees nedenfor, er den af Observationerne udledede Solradius storre.

Som Observationsuhr benyttedes dels Lommechronometer, dels Lommeuhre, der umiddelbart for eller efter hver Observationsrække sammenlignedes med Hovedchronometret Reid. Hr. Tornøe, vor Chemiker, assisterede mig ved flere Observationer, idet han noterede Uhret. Reids Correction til Greenwich Middeltid beregnedes for Observationerne

	Juli 30	Juli 31	Aug. 1
til	$+ 8^m\ 28.^s6$	$+ 8^m\ 29.^s2$	$+ 8^m\ 30.^s2$

Efter forelobige Beregninger sattes for Ankerpladsen paa Østsiden $\varphi_0 = 70^\circ\ 58.'0$ og $\lambda_0 = 0^h\ 33^m\ 48.^s3$ W. Greenwich.

Beliggenheden af Ankerpladsen paa Vestsiden er ret nøje bestemt trigonometrisk i Forhold til Ankerpladsen paa Østsiden. Ved Hjelp af Stormastens Højde, 18.6 Meter, der fra en Baad af Capt. Wille maaltes i Vinkel til $4^\circ\ 20.'3$, fandtes Baadens Afstand fra Skibet $= 245$ Meter. Fra Baaden og fra Skibet (Mohn) sigtedes samtidig til Toppen af "Fugleberget", en fremtrædende let kjendelig Fjeldtop paa Øens Vestside ved Mary Muss Bugten. Vinkelen Fugleberg—Skib, seet fra Baad, var $86^\circ\ 3.'7$. Vinkelen Fugleberg—Baad, seet fra Skibet, var $90^\circ\ 13.'3$, hvoraf beregnes Afstanden fra Skibet til Fugleberget til $2.'03$. Fuglebergets Azimuth fra Skibet fandtes efter 3 Compas-Pejlinger paa 3 forskjellige Kurser = N. 25° W. Derefter ligger Fugleberget $1'\ 50.''4$ nordligere og $2'\ 38.''0$ vestligere end Ankerpladsen paa Østsiden. Fra Fuglebergets Fod maalte jeg den 29de Juli Masthojden til $0^\circ\ 55.'5$, hvilket giver en Afstand af $0.'62$. Skibets Azimuth fra Fugleberget var her omtrent 70°. Heraf beregnes, at

The following day, July 31st, the Expedition anchored in Great Wood Bay, on the east coast of the island. The swell preventing us from landing, Capt. Wille and myself took a series of solar altitudes on board, with different sextants. The atmospheric conditions were not favourable, cloud and mist repeatedly blotting out the sun or the horizon.

On the 1st of August the weather cleared a little, and in the forenoon a few solar altitudes were observed from the same anchorage, shortly before we got under weigh.

In the Table given below, G signifies Capt. Grieg, and M, Professor Mohn; E signifies the sextant belonging to the Expedition, and S a sextant belonging to the vessel.

Each observer determined his index-error. For the Troughton sextant, I found the index-error, on the 31st of July, to be $+ 1' 38''$ by the sun, and $+ 1' 35''$ by the horizon. The first of these values was applied.

Most of the observations were made from the deck of the roundhouse, where the eye of the observer was assumed to be 18 Norwegian feet, or 5.6 metres, above the sea-level.

For these computations, the sun's semidiameter was taken from the Nautical Almanac. As will appear in the sequel, that deduced from the observations was somewhat greater.

We observed with the pocket-chronometer and ordinary watches, each timepiece being compared, immediately before and after a series of observations, with our chief chronometer, the Reid. Mr. Tornøe, chemist to the Expedition, assisted me in several of the observations, by noting the indications of the watch. The Reid correction to Greenwich mean time was computed for the observations taken —

	July 30	July 31	Aug 1
at	$+ 8^m\ 28.^s6$	$+ 8^m\ 29.^s2$	$+ 8^m\ 30.^s2$

For the anchorage on the east coast of the island, I put, as the result of preliminary computations, $\varphi_0 = 70^\circ\ 58.'0$ and $\lambda_0 = 0^h\ 33^m\ 48.^s3$ W. Greenwich.

The position of the anchorage off the west coast of the island relative to that of the anchorage on the east side, was determined trigonometrically with tolerable exactness. Taking the height of the mainmast, 18.6 metres, which, as measured from a boat by Capt. Wille, gave an angle of $4^\circ\ 20.'3$, the distance of the boat from the ship was found to be 245 metres. From the boat and from the ship (Prof. Mohn), we simultaneously observed the summit of the "Fugleberg" (bird-cliff), a conspicuous mountain-top on the west side of the island, in close proximity to Mary Muss Bay. The angle Fugleberg—ship, as determined from the boat, was $86^\circ\ 3.'7$; the angle Fugleberg—boat, as determined from the ship, $90^\circ\ 13.'3$; and with these results the distance from the ship to Fugleberg was computed at $2.'03$. The azimuth of Fugleberg from the ship, we found from 3 compass-bearings on 3 different courses = N. 25° W. The Fugleberg should accordingly lie $1'\ 50.''4$ farther north and $2'\ 38.''0$ farther west than our

Ankerpladsen paa Vestsiden ligger 10.″9 nordligere og 1′ 49.″1 vestligere end Fugleberget. Ankerpladsen paa Vestsiden ligger altsaa 2′ 1.″3 nordligere og 4′ 27″ vestligere end Ankerpladsen paa Østsiden. Er for den sidste $\varphi_0 = 70^\circ\ 58.'0$ og $\lambda_0 = 0^h\ 33^m\ 48.^s3$, saa bliver for Ankerpladsen paa Vestsiden $\varphi_0 = 71^\circ\ 0'\ 1''$ og $\lambda_0 = 0^h\ 34^m\ 6.^s1$.

Efter de mindste Kvadraters Methode beregnede jeg de sandsynligste Correctioner til φ_0 og λ_0.

Naar jeg derefter grupperede Differentserne (hvis Kvadratsum er Minimum) mellem de observerede (reducerede) Højder af Solcentret og de efter de fundne sandsynligste Værdier for Bredden og Længden beregnede, efter de observerede Solrender, viste det sig, at Middeldifferentsen for øvre Rand var + 0.′295 og for nedre Rand — 0.′282. Den observerede Solradius er saaledes gjennemsnitlig 0.′3 større end den til Beregningen benyttede. Corrigeres med denne Størrelse, faaes de i den følgende Tabel anførte Værdier af Differentserne Δ mellem observeret minus beregnet Solhøjde. I Tabellen ere alle Uhrtider reducerede til Reid, og alle maalte Solhøjder corrigerede for Indexfejl, Kimmingdaling, Refraction, Parallaxe og Solradius (Naut. Almanac's). *o* betegner øvre Solrand, *n* nedre Solrand. Aflæsningerne paa Sextanten ere gjorte i Secunder og Reductionen udført med Secunder, men da den sandsynlige Fejl af en enkelt Højde er over et halvt Minut, opføres i Tabellen Tiendedels Minut, ligesom Beregningen efter de mindste Kvadraters Methode er ført med femzifrede Logarithmer.

anchorage off the east coast. From the foot of the Fugleberg, the height of the mast, as measured by myself on the 29th of July, gave an angle of 0° 55.′5, which corresponds to a distance of 0.′62. At this point, the azimuth of the ship from the Fugleberg was about 70°. Computing with these results, our anchorage off the west coast should lie 10.″9 farther north and 1′ 49.″1 farther west than the Fugleberg. Hence, the anchorage off the west coast lies 2′ 1.″3 farther north and 4′ 27″ farther west than the anchorage off the east coast. Assuming for the latter $\varphi_0 = 70^\circ\ 58.'0$ and $\lambda_0 = 0^h\ 33^m\ 48.^s3$, for the anchorage off the west coast $\varphi_0 = 71^\circ\ 0'\ 1''$ and $\lambda_0 = 0^h\ 34^m\ 6.^s1$.

By the method of the least squares, I computed the most probable corrections of φ_0 and λ_0.

Then, on grouping the differences (the sum of the squares of which is a minimum) between the observed (duly corrected) altitudes of the sun's centre and those computed with the most probable values found for latitude and longitude, according to the observed solar limbs, the mean difference for the upper limb proved to be + 0.′295, and for the lower — 0.′282. On an average, therefore, the observed semidiameter of the sun is 0.′3 greater than that taken for the computation. Corrected with this quantity, we get the values given in the following Table for the differences, Δ, between the observed and the computed solar altitudes. In this Table all chronometer-times are reduced to those of the Reid chronometer, and all observed altitudes corrected for the index-error, the dip of the horizon, refraction, parallax, and the sun's semidiameter (from Naut. Almanac): *o* signifies upper solar limb, *n* lower solar limb. The readings of the sextant were noted in seconds, and their reduction computed in seconds; but the probable error of a single altitude amounting to more than half a minute, tenths of a minute have been given in the Table. The computation by the method of the least squares is made with five decimals in the logarithms.

Ankerplads paa Vestsiden. 1877. Juli 30.

(Anchorage on the West Side. 1877. July 30.)

Chron. Reid.	Obs. Højde. (Obs. Altitude.)	Rand. (Limb.)	Sext.	Obs.	Δ
$5^h\ 47^m\ 28^s$	$20^\circ\ 57.'2$	*n.*	*E.*	*G.*	+ 0.′9
5 48 1	20 56.4	*n.*	*S.*	*M.*	— 1.3

Ankerplads paa Østsiden. Obs. Capt. Wille.

(Anchorage on the East Side.)

Chron. Reid.	Obs. Højde. *(Obs. Altitude.)*	Rand. *(Limb.)*	Sext.	$\varDelta$
Juli *(July)* 31. 0^h 38^m 59^s	37° 11.'2	*n.*	*S.*	— 1.'1
0 59 18.5	37 2.4	*n.*	*S.*	— 0.4
1 11 56	36 51.6	*n.*	*E.*	— 0.1
1 28 42.5	36 30.3	*n.*	*E.*	— 0.7
22 42 17	34 32.2	*n.*	*E.*	— 2.1

De 4 første er givet dobbelt Vægt, da de bero paa flere Observationer hver. Man ser, at den observerede Solradius er større end min, sandsynligvis paa Grund af, at der er benyttet svagere Blændglas.

To the first 4 altitudes is attached double weight, each being the mean of several observations. The observed semidiameter of the sun is greater than mine, probably from lighter coloured glasses having been used.

Ankerplads paa Østsiden. Troughton's Sextant.

(Anchorage on the East Side.)

Iagttager *(Observer)*: Mohn. 1877. Juli *(July)* 30—31.

Chron. Reid.	Rand. *(Limb.)*	Obs. Højde. *(Obs. Altitude.)*	$\varDelta$
22^h 35^m 37.'9	*n.*	34° 31.'4	+ 0.'6
37 58.6	*n.*	37.4	+ 0.4
0 22 54.0	*n.*	37 11.5	— 1.0
37 37.5	*o.*	14.9	+ 1.7
40 18.3	*n.*	11.3	— 0.8
42 39.0	*n.*	11.0	— 0.5
48 25.5	*o.*	10.4	+ 0.4
58 39.6	*n.*	4.0	+ 0.5
1 0 19.5	*o.*	2.7	— 0.1
13 18.0	*n.*	36 49.1	— 1.4
15 9.9	*o.*	50.0	— 1.2
19 23.6	*o.*	46.0	+ 1.9
20 57.4	*n.*	41.9	+ 0.4
22 11.2	*n.*	39.3	— 0.6
23 41.1	*o.*	38.5	— 0.1
25 5.0	*o.*	36.7	— 0.1
26 23.0	*n.*	34.5	+ 0.1
27 31.9	*n.*	32.7	0.0
29 18.7	*o.*	30.4	— 0.4
29 44.6	*o.*	28.2	— 2.0
32 36.5	*o.*	26.4	+ 0.6

Chron. Reid.	Rand. *(Limb.)*	Obs. Højde. *(Obs. Altitude.)*	$\varDelta$
1^h 33^m 58.'3	*n.*	36° 22.'4	— 0.'7
46 23.3	*o.*	2.2	— 0.1
47 23.2	*o.*	0.2	— 0.3
48 37.0	*o.*	35 58.7	+ 0.6
49 21.0	*o.*	56.3	— 0.5
49 55.0	*o.*	55.3	— 0.3
50 39.0	*o.*	54.0	— 0.3
51 20.4	*o.*	53.9	+ 1.3
52 32.8	*n.*	50.1	+ 0.4
53 29.2	*n.*	47.9	+ 0.1
54 22.1	*n.*	46.4	+ 0.2
55 7.6	*n.*	45.3	+ 0.7
56 47.5	*n.*	41.9	+ 0.7
58 35.4	*n.*	37.6	+ 0.3
2 0 29.7	*n.*	35.4	+ 2.1
22 41 38.0	*o.*	34 33.2	+ 0.5
43 57.5	*o.*	39.0	+ 0.4
48 13.0	*o.*	49.6	+ 0.5
23 19 19.6	*n.*	35 54.9	+ 0.6
22 34.0	*n.*	59.2	— 0.8
23 59.8	*n.*	36 2.9	+ 0.4

Af alle Observationer findes $\delta = \pm 0.'57 = \pm 34''$.

$\varDelta q = + 0.'07 \pm 0.'09 = + 4.''5 \pm 5.''5$.
$\varDelta\lambda = - 2.'35 \pm 0.'66 = - 2'\ 20.''9 \pm 39.''8 =$
$- 9.^s39 \pm 2.^s65$.

All the observations taken together give $\delta = \pm 0.'57 = \pm 34''$.

$\varDelta q = + 0.'07 \pm 0.'09 = + 4.''5 \pm 5.''5$.
$\varDelta\lambda = - 2.'35 \pm 0.'66 = - 2'\ 20.''9 \pm 39.''8 =$
$- 9.^s39 \pm 2.^s65$.

En constant Fejl af 10″ i Højderne vil forandre den beregnede Bredde saa meget som 10.″02 og den beregnede Længde saa meget som 0.′52. Resultatet bliver saaledes for Ankerpladsen paa Østsiden

A constant error of 10″ in the altitudes will change the computed latitude as much as 10.″02, and the computed longitude as much as 0.′52. Hence, the result for our anchorage off the east coast is —

$$\varphi = 70^\circ\ 58'\ 4.''5 \pm 11.''4$$
$$\lambda = 8\ 24\ 43.\ 7 \pm 41.\ 0 = 0^h\ 33^m\ 38.^s9 \pm 2.^s73 \text{ W. Greenwich.}$$

og for Fuglebergets Top

and for the summit of the Fugleberg —

Bredde *(Latitude)*	70° 59′ 55″ ± 11.″4	
Længde *(Longitude)*	8 27 22 ± 41. 0	= 0ʰ 33ᵐ 49.ˢ5 ± 2.ˢ73 W. Greenwich.

Scoresby's Kart[1], paa hvilket Fugleberget let kan identificeres, lægger dette 1.′6 nordligere og 31′ (10 Kvartmil) østligere end min Bestemmelse. Scoresby's Observationer gjordes den 3die og 4de August 1817. I 1878 fandt den hollandske Expedition med Skonnerten „Willem Barendsz", at Jan Mayen ligger vestligere end paa Scoresby's Kart. Efter min Bestemmelse er Øen aflagt paa det af Capt. Wille og mig over samme udarbejdede nye Kart, der følger senere i denne Generalberetning.[2]

Scoresby's Map,[1] on which the Fugleberg may be easily found, places that mountain 1.′6 north and 31′ (10 miles) east of my determination. Scoreby's observations were taken on the 3rd and 4th of August 1817. In 1878, the Dutch Expedition, with the schooner „Willem Barendsz," found the Island of Jan Mayen to lie farther west than it does on Scoresby's map. For the new map of Jan Mayen constructed by Capt. Wille and myself, — to be subsequently published in the General Report,[2] — the position of the island was laid down from my own determination of latitude and longitude.

[1] An Account of the Arctic regions.
[2] Ogsaa publiceret i Petermann's Mittheilungen f. 1878 Taf. 13 og i den nye Udgave af Stieler's Hand-Atlas.

[1] An Account of the Arctic Regions.
[2] This Map has already appeared in Petermann's Mittheilungen for 1878, Pl. 13, and in the new Edition of Stieler's Hand-Atlas.

C. Wille. Magnetiske Observationer.

Efter den for Nordhavs-Expeditionen lagte Plan skulde der søges udført Observationer til Bestemmelse af Jordmagnetismens Elementer saavel i Land som i Søen. Til dette Øjemed anskaffedes og medbragtes følgende Instrumenter:

Et Unifilar-Magnetometer, No. 38, af Elliott Brothers i London. Instrumentet blev verificeret og dets Konstanter bestemte ved Observatoriet i Kew.

En liden Theodolit af Olsen i Kristiania, laant af den geografiske Opmaaling.

Et Inklinatorium af John Dover, Charlton, Kent, undersøgt i Kew.

Et Admiralitets-Standard-Kompas, verificeret ved Kompas-Observatoriet i Deptford.

Flere Azimuth-Kompasser.

En Fox-Cirkel No. 30 af John Dover, med Hjælpeapparater og Slingrebord.

Flere Kronometre og Sextanter.

Et Observationstelt fra Bergens Arsenal, velvillig udlaant af Armé-Intendanten.

Jeg skal nu særskilt behandle Observationerne paa Landstationer og Observationerne i Søen.

C. Wille. Magnetical Observations.

The Scheme of Work approved for the Norwegian North-Atlantic Expedition, was, if possible, to comprise observations for determining the elements of terrestrial magnetism, alike on shore and at sea. With this object in view, the following instruments were provided.

A Unifilar Magnetometer, No. 38, made by Elliott Brothers, of London. This instrument was verified, and had its constants determined, at the Kew Observatory.

A small Theodolite, by Olsen of Christiania, obtained on loan from the Geographical Survey.

A Dip-Circle, by John Dover, of Charlton, Kent, examined at Kew.

An Admiralty Standard-Compass, verified at the Compass Observatory, Deptford.

Several Azimuth-Compasses.

A Fox-Circle, No. 30, by John Dover, with auxiliary apparatus and gimbal-table.

Several Chronometers and Sextants.

A Tent, kindly lent from the Bergen Arsenal.

I will now pass on to the observations, describing separately those taken at the land-stations and those made at sea.

A. Observationer paa Land-Stationer og deres Resultater.

a. Deklination.

Begge til Magnetometret hørende Magneter var Kollimations-Magneter, med Skalaer i Objectivglassets Brændplan. Da Instrumentet ikke var forsynet med Plan-Spejl til Deklinationsbestemmelse, men kun havde et Hulspejl til at

A. Observations at Land-Stations, and their Results.

a. Declination.

Both of the magnets belonging to the magnetometer were collimator-magnets, with the scale in the focal plane of the object-glass. The instrument not being provided with a plane mirror for observing the declination, but

belyse Magnetens Skala, maatte en særskilt Theodolit anvendes til Bestemmelse af Azimut. Theodoliten opstilledes i 1876 paa sit eget Stativ med sin Kikkert i samme Højde som Magneten og saa nær denne som muligt. Da dette voldte meget Bryderi, lod jeg forfærdige paa Hortens mekaniske Verksted et Underlag af Messing, der kunde lægges paa Magnetometret og fæstes til dette ved Hjælp af de samme Indretninger, som anvendtes ved Deflektionsstangens Befæstigelse. Paa den ene Side af dette Underlag anbragtes Theodoliten, med Fodskruerne i smaa dertil afpassede Huller, og paa den anden Side en Modvægt af Bly. Det var med denne Indretning altid let at faa se og kunne indstille Magnetskalaens Midtstreg paa Theodolitens Vertikalfilament. Observationerne udførtes i Regelen paa følgende Maade:

Ophængningstraadens Torsion ophævedes. Theodoliten nivelleredes, og indstilledes med Filamentet paa Skalaens Midtstreg i Magneten, hvorefter Theodolitens Nonier aflæstes (Magn. I).

Theodoliten drejedes, saaledes at dens Kikkert pegede lidt vestenfor Solen, i Solcentrets Højde, og fastklemtes. Tidspunkterne for Overgangen af forangaaende og efterfølgende Rand af Solen over Vertikalfilamentet noteredes efter Kronometer. Denne Iagttagelse gjordes enten med Blændglas foran Okularet eller ved at projicere Solens og Filamentets Billede paa en hvid Skjærm. I mange Tilfælde var der to Iagttagere, af hvilke den ene observerede Solrandenes Passage og raabte "Nu" i det Øjeblik, de tangerede Filamentet, medens den anden observerede og noterede tilsvarende Øjeblikke efter Kronometret. Nonierne aflæstes.

Kikkerten lagdes om gjennem Zenit (Nadir), drejedes 180° om Vertikalaxen og begge Solrandes Passage observeredes i denne Stilling efter Kronometret, ligesom Nonierne aflæstes.

Magneten omlagdes, idet den drejedes 180° om sin Længdeaxe, og Filamentet i Theodolitkikkerten indstilledes atter paa Magnetskalaens Midtstreg, og Nonierne aflæstes. (Magn. II).

Naar Omstændighederne tillod det, observeredes atter Magneten i Stillingen I. Stundom blev den omlagt flere Gange.

Ligesaa flyttedes, ved saadanne Lejligheder, Theodoliten ved den følgende Sats saaledes, at Fodskruerne kom hver i andre Huller, hvorved dens Cirkels Nulpunkt forandredes 120°. Det viste sig imidlertid, at dens Delingsfejl ikke var saa betydelige, at denne Vexling af Stilling var nødvendig for at opnaa den forlangte Nøjagtighed af c. 1 Minut.

I flere Tilfælde bestemtes Azimut af en Mire, til hvilken Observationen af Magneten i begge Stillinger blev knyttet.

Kronometrets Stand blev i de fleste Tilfælde bestemt ved Solhøjder tagne med Sextant paa Observations-

having only a concave mirror by which to illuminate the scale of the magnet, the azimuth had to be determined with a separate theodolite. In 1876, the theodolite was mounted on its own stand, with the telescope facing the magnet, and as near it as possible. This, however, proving excessively troublesome, I procured from the Horten Mechanical Works a brass support, which, when placed upon the magnetometer, could be attached in the manner adopted for fixing the deflection-rod. On one side of this brass support was mounted the theodolite, with the foot-screws fitting into holes made for the purpose, the other side being given a counterpoise of lead. With this arrangement, the scale of the magnet could be easily sighted, and the middle division bisected by the vertical wire of the theodolite. The observations were generally taken as follows: —

The torsion of the suspension thread having been first removed, the theodolite was levelled, and the wire made to bisect the middle division of the scale of the magnet, after which the verniers of the theodolite were read off (Magn. I). The theodolite was then moved in azimuth and altitude till its teloscope pointed a little to the west of the sun, at the altitude of the sun's centre, and clamped in that position. The times for the transit of the preceding and following limbs of the sun across the vertical wire, were noted by a chronometer. This observation was taken either with a coloured glass before the eye-piece or by projecting the image of the sun and the wire on a white screen. Frequently, there were two observers, in which case one observed the transit of the solar limbs, calling out at the moment they were tangent to the wire, while the other observed and noted the corresponding readings of the chronometer. Then, after reading off the verniers, the telescope was turned through the zenith (nadir), moved 180° on its vertical axis, and the transits of both solar limbs observed in that position by the chronometer, the verniers being also read off.

The magnet was now inverted, being turned 180° about its longitudinal axis, and the wire of the telescope of the theodolite again made to bisect the middle division of the scale of the magnet, after which the verniers were read off (Magn. II).

Circumstances permitting, the magnet was again observed in position I. Occasionally, it was inverted several times.

Moreover, on such occasions the theodolite was so moved previous to the following set of observations, that the foot-screws should correspond with different holes, and change the zero of its circle by 120°. Its errors of division, however, did not prove so considerable as to render imperative such change in position for attaining the desired accuracy of about one minute.

In several cases, the azimuth of a mark was determined from the observations of the sun, and the observations of the magnet, in both positions, connected with the direct observations of the mark.

As a rule, the error of the chronometer was found from solar altitudes, taken with the sextant at the place

stedet. Herom kan jeg henvise til den foranstaaende Afhandling af Professor Mohn. Kronometrenes Gang bestemtes efter Sammenligning med det ombord værende Normalkronometer, hvis Stand og Gang var bestemt væsentlig efter telegrafiske Tidssignaler fra Christiania Observatorium[1]. Paa et Par Steder toges Kronometrets Stand efter dets Stand for Greenwich Tid og Længden af Observationsstedet efter Kystkartet.

Observationerne af alle Elementer gjordes i Teltet. Ved Observation af Solen aabnedes Teltet netop saavidt i Rum og Tid, som var nødvendigt.

of observation. For details on this head, I can refer to the foregoing Memoir, by Professor Mohn. The rate of the chronometer was determined by comparison with the standard chronometer on board, the error and rate of which were found chiefly by means of the time-signals telegraphed from the Christiania Observatory[1]. At one or two points, the error of the chronometer was taken from its error on Greenwich time and the longitude of the place of observation on the coastal chart.

The observations of all the elements were made in the tent. For observations of the sun, the tent was opened to just the necessary extent in space and time.

b. Horizontal Intensitet.

Observationerne og Beregningerne udførtes efter Instruktionerne i "A Manual of Scientific Enquiry"; Fourth Edition, 1871 Side 96 til 101. Unifilar-Magnetometrets Konstanter var ved Kew-Observatoriet bestemte saaledes:

Correction for Delingsfejl ved Afbøjningsstangen
ved 1 Foot. = + 0.00002 Foot. } ved 62° F.
„ 1.5 — = + 0.00004 — }
Svinge-Magnet, Værdi af 1 Skaladel = 1.′9.
Afbøjningsmagnetens Correction til 35° F = 0.000130 $(t_0 - 35) + 0.00000056\ (t_0 - 35)^2$.
Induktionskoefficient μ = 0.000195.
Log π^2 K ved 60° F = 1.69708.
Der er desuden givet forskjellige Hjælpetabeller, blandt hvilke en for Værdierne af Log. π^2 K og Log $\frac{1}{2}$ r^3 for forskjellige Temperaturer:

b. Horizontal Intensity.

The observations and computations were made in accordance with the instructions contained in "A Manual of Scientific Enquiry;" Fourth Edition, 1871, pp. 96—101. The constants of the Unifilar Magnetometer had been determined at the Kew Observatory, as follows: —

Correction for errors of division of Deflecting Rod
at 1 Foot = + 0.00002 foot } at 62° F.
„ 1.5 - = + 0.00004 „ }
Vibration Magnet, value of 1 division of Scale = 1.′9.
Deflecting Magnet, correction to 35° F. = 0.000130 $(t_0 - 35) + 0.00000056\ (t_0 - 35)^2$.
Coefficient of Induction μ = 0.000195.
Log π^2 K at 60° F = 1.69708.
Moreover, divers auxiliary Tables are annexed, one of which gives the values of Log. π^2 K and of Log. $\frac{1}{2}$ r^3 at different temperatures.

Temp. F	Log. π^2 K	Log. $\frac{1}{2}$ r^3 $r_0 = 1.0$	Log. $\frac{1}{2}$ r^3 $r_0' = 1.3$
30	1.69690	9.69859	0.04041
40	696	872	054
50	702	885	067
60	708	898	080
70	714	911	093
80	720	924	106
90	1.69726	9.69937	0.04119

Som Exempel paa Observationernes Udførelse og Beregning hidsættes følgende, efter de fra Kew erholdte trykte Blanketter udfyldte, Skemata.

To show the mode of taking and computing the observations, copies of the printed forms in use at Kew Observatory have been filled out, and here subjoined.

[1] Se den citerede Afh. Side 2.

[1] See Professor Mohn's Memoir, p. 2.

Observations of Deflection, 2nd of October 1876.

Station Christiania; Lat. 59° 54′ 43″, Long. 10° 43′ 37″.
Mean Time at Station; commencing 0^h 36^m p. m., ending 1^h 20^m p. m.
Magnet (A) deflecting; (B) suspended.

Deflecting Magnet Distance	N. End.	Temp.	Readings of Verniers	Mean of Verniers	Corrected Circle Reading	Means and Differences	
East							
1 Foot	E.	53.°4	143° 17′ 40″ 17 20	143° 17′ 30″	143° 17′ 30″ 143 9 50	143° 13′ 40″ 90 23 40	
1 ..	W.	53. 4	90 21 0 21 20	90 21 10	 90 21 10	52 50 0	Diff.
1.3 ..	E.	53. 3	128 13 20 13 20	128 13 20	26 10	26 25 0	u_0
1.3 ..	W.	53. 2	105 7 40 8 0	105 7 50			
West							
1 Foot	W.	53.°4	90° 26′ 0″ 26 20	90° 26′ 10″	128° 13′ 20″ 22 10	128° 17′ 45″ 105 10 25	
1 ..	E.	53. 4	143 9 40 10 0	143 9 50	 105 7 50	23 7 20	Diff.
1.3 ..	W.	53. 0	105 13 0 13 0	105 13 0	13 0	11 33 40	u'_0
1.3 ..	E.	53. 0	128 22 0 22 20	128 22 10			

Mean $t_0 = \begin{array}{r} 53^\circ\ 26 \\ -\ \ 8 \\ \hline 52.^\circ 5 \end{array}$ Observed Angles of Deflection $(u_{,0})$ $\begin{array}{l} r_0 = 1.0 = 26^\circ\ 25'\ \ 0'' \\ r'_0 = 1.3 = 11\ \ 33\ \ 40 \end{array}$

$$\frac{m_0}{X_0} = \tfrac{1}{2} r^3 \sin u_0; \qquad \frac{m'}{X'} = \frac{m_0}{X_0}\left\{1 + \frac{2\mu}{r_0^3} + q(t_0 - t)\right\}; \qquad \frac{m}{X} = \frac{m'}{X'}\left(1 - \frac{P}{r_0^2}\right).$$

$r = 1.0 \quad r' = 1.3 \qquad\qquad r' = 1.3$

			$\tfrac{1}{2} r^3$ Log. =	9.69888 0.04070
$1 + \frac{2\mu}{r_0^3} =$	1.00039	1.00086	Sin. u_0 Log. =	9.64826 9.30193
$+ (t_0 - t)\, q =$	0.00244	0.00244	$\frac{m_0}{X_0}$ Log. =	9.34714 9.34263
$1 + \frac{2\mu}{r_0^3}(t_0 - t)\, q =$	1.00283	1 00330	Log. =	0.00123 0.00143
			$\frac{m'}{X'}$ Log. =	9.34837 9.34406
$1 - \frac{P}{r_0^2} =$	0.97618		Log. =	9.98953 9.99384
			$\frac{m}{X}$ Log. =	9.33790 9.33790
			mX Log. =	0.41767
			$mX - \frac{m}{X} = X^2$ Log. =	1.07977
			$3.4664 = X =$ Log. =	0.53988
			$0.7547 = m =$ Log. =	9.87779
Observer *Carl Wille.*			Red. to Metr. Un. Log. =	9.66378
			$1.5983 = X =$ Log. =	0.20366

Observations of Vibration, 2nd of October 1876.

Station Christiania; Lat. 59° 54′ 43″, Long. 10° 43′ 37″.
Chronometer. Error at Station = $0^h\ 42^m\ 38^s$ Daily Rate (s) = 4.5 Accl.
Magnet (A) suspended.
Effect of 90° of Torsion = 2.26 Div. = 4.′29. One Div. of Scale = 1.′9.

	Mean Time at Station	Semiarc of Vib.	Temp. of Magnet	
At Commencement	$1^h\ 50^m$ p. m.	76′	55.°0	t_o = 55.°0
At End	2 2	22.8		t_o = 55. 0

Scale moving apparently to the Right					Scale moving apparently to the Left				
No. of Vib.	Time of Centre passing wire	No. of Vib.	Time of Centre passing wire	Time of 100 Vib.	No. of Vib.	Time of Centre passing wire	No. of Vib.	Time of Centre passing wire	Time of 100 Vib.
0	$2^h\ 33^m\ 21.^s7$	100	$40^m\ 38.^s1$	$7^m\ 16.^s4$	5	$2^h\ 33^m\ 43.^s5$	105	$41^m\ 00.^s0$	$7^m\ 16.^s5$
10	34 5.3	110	41 21.7	16.4	15	36 27.1	115	41 43.5	16.4
20	34 49.0	120	42 5.5	16.5	25	35 10.7	125	42 27.1	16.4
30	35 32.7	130	42 49.2	16.5	35	35 54.5	135	43 11.0	16.5
40	36 16.3	140	43 33.0	16.7	45	36 38.0	145	43 54.5	16.5
50	37 0.0	150	44 16.5	16.5	55	37 21.7	155	44 38.3	16.6
Diff.	3 38.3			30	Diff.	3 38.2			29
100 at	2 40 38.3		Mean (1) =	7 16.5	105 at	40 59.9		Mean (2) =	7 16.48

$$T_{,} = T_{o} \left\{ 1 - \frac{s}{86400} - \frac{aa'}{16} \right\}. \quad T^2 = T_{,}^2 \left\{ 1 + \frac{H}{F} - q(t_o - t) + \mu \frac{X_o}{m_o} \right\}. \quad mX = \frac{\pi^2 K}{T^2}.$$

$1 - \frac{s}{86400} = 0.99995$ | Mean (1) = 7^m 16.50
(2) = 7 16.48

$-\frac{aa'}{16} = 0.00001$ | T_o = 4.′3649 | Log. = 0.63997

$1 - \frac{s}{86400} - \frac{aa'}{16} = 0.99994$ . . . . Log. = 9.99997

$T_{,}$ Log. = 0.63994
2

$1 + \frac{H}{F} = 1.00079$

$-q(t_o - t) = 0.00282$ | $T_{,}^2$ Log. = 1.27988

$+\mu : \frac{m_o}{X_o}$ 0.99997
= 0.00088

$1 + \frac{H}{F} - q(t_o - t) + \mu - \frac{m_o}{X_o} = 0.99885$ . . . . Log. = 9.99950

T^2 Log. = 1.27938
$\pi^2 K$ Log. = 1.69705

μ Log. = 6.29003

$\frac{m_o}{X_o}$ Log. = 9.34714 | $mX = \frac{\pi^2 K}{T^2}$ Log. = 0.41767

$\mu \div \frac{m_o}{X_o} = 0.00088$ Log. = 6.94289 | $\frac{m'}{X'}$ Log. = 9.34837

$mX - \frac{m'}{X'} = X'^2$ Log. = 1.06930
$X' = 3.4249$ Log. = 0.53465
m'^2 Log. = 9.76604
$m' = 0.76387$ Log. = 9.88302

Observation of Torsion.

	Circle turned		Scale	Mean	Diff.
	0°	=	40		
+	180°	=	44.3	39.75	4.55
	0°	=	39.5		
—	180°	=	35.5	40. 0	4.5
	0°	=	40.5		4.5

90 = 2.26 = 4.′29

Observer *Carl Wille.*

c. **Inklination.**

Det Doverske Inklinatorium havde tre Naale. Aflæsningen af Naalespidsene sker ved Mikroskoper. Nonierne angiver Minutter. Observationerne udfortes og beregnedes efter Instruktionerne i Manual of Scientific Enquiry Side 103—105. Folgende Skema benyttedes:

c. **Inclination.**

Dover's Dip-Circle had three needles. The ends of the needles are observed with microscopes. The verniers read minutes. The observations were taken and computed in accordance with the instructions in "A Manual of Scientific Enquiry," pp. 103—105. The printed form was as follows:

Magnetic Dip.

Station Christiania. Date 2nd of October 1876.
Needle No. 1.
Setting of Azimuth Circle 64° 49′ + 64° 28′ = 64° 38′.
Remarks . . . . . Magnetical Pillar in the Park of the Observatory.
Time 10^h 55^m a. m. to 0^h 5^m p. m.

	Face of Instr.	Poles direct B dipping, Readings of Needle: Lower end	Upper end	Mean	Poles reversed A dipping, Readings of Needle: Lower end	Upper end	Mean
Face of Needle to face of Instrument	EAST	71° 5.′5	71° 6.′0	71° 5.′7	71° 10′	71° 12′	71° 11.′0
		4. 5	5. 5	5. 0	9	12	10. 5
		4. 0	4. 0	5. 0	9	11	10. 0
		Mean = a		71 5. 2	Mean = b		71 10. 5
	WEST	71 0	70 58	70 59	71 1	70 58	59. 5
		0	59	59. 5	1	58	
		0	71 0	60			
		Mean = a'		70 59. 5	Mean = b'		70 59. 5
Face of Needle reversed	WEST	71 17	71 14	71 15. 5	71 21. 5	71 20	71 20. 7
		16	14	15	21	19	20. 0
		15	13	14	20	19	19. 5
		Mean = a''		71 14. 8	Mean = b''		71 20. 1
	EAST	71 7	71 10	71 8.5	70 41	70 43	70 42. 0
		3	6	4. 5	41	43	42. 0
		5	8	6. 5	40	43	41. 5
		Mean = a'''		71 6. 5	Mean = b'''		70 41. 8
			a''	71 14. 8		b''	71 20 1
			a'	70 59. 5		b'	70 59. 5
			a	71 5. 2		b	71 10. 5
				4 | 26. 0			4 | 11. 9
		Mean of Means =		71° 6.′5	Mean of Means = β		71° 2.′97
					Do. Do. = α		71 6. 5
					$\alpha + \beta$ Dip		9. 47
					2		71 4. 74

Observer *Carl Wille.*

1. Bergen.

Ved Observatoriet paa Nordnes. Bredde $\varphi = 60^\circ\ 23'\ 54''$. Længde $\lambda = 5^\circ\ 24'\ 0''$ E. Greenwich.

Horizontal-Intensitet.

1876, Mai 22.

Afbøjnings-Observation Kl. 12 til 1,30 Min. Eft.

Temperatur $t_0 = 62.^\circ5$ F. Afbøjningsvinkel, for Afstanden $r_0 = 1$ Fod, $u_0 = 28^\circ\ 58'\ 55''$. Iagttager C. Wille.

Svingnings-Observation Kl. 2,6 Min. til 2,18 Min. Eft.

Temperatur $t_0 = 65.^\circ5$ F. Observeret Svingetid $T_0 = 4.'4919$. Kronometret vinder daglig 3ˢ. Halve Svingebue ved Begyndelsen $\alpha = 77.'9$, ved Enden $\alpha' = 24.'7$. Torsion for en Dreining af 90°, $u = 11.'78$. Iagttager C. Wille.

Resultat. Med $P = 0.02300$ faaes $m = 0.76660$ og Horizontalintensitet $X = 3.2238$.

Inklination.

Kl. 3,0 til 4,30 Min. Eft. Naal No. 1. C. Wille.

Resultat. $\theta = 72^\circ\ 24.'3$.

1. Bergen.

Observatory at Nordnes; latitude $\varphi = 60^\circ\ 23'\ 54''$, longitude $\lambda = 5^\circ\ 24'\ 0''$ E. Greenwich.

Horizontal Intensity.

1876, May 22.

Observation of Deflection: 12 a. m. to 1,30 p. m.

Temperature $t_0 = 62.^\circ5$ F.; angle of deflection for the distance $r_0 = 1$ foot, $u_0 = 28^\circ\ 58'\ 55''$. Observer C. Wille.

Observation of Vibration: 2,6 p. m. to 2,18 p. m.

Temperature $t_0 = 65.^\circ5$ F.; observed time of one vibration $T_0 = 4.'4919$; chronometer gaining daily 3ˢ. Semi-arc of vibration at commencement $\alpha = 77.'9$, at end $\alpha' = 24.'7$. Torsion for a twist of 90°, $u = 11.'78$. Observer C. Wille.

Result. — With $P = 0.02300$, m will be $= 0.76660$ and the horizontal intensity $X = 3.2238$.

Inclination.

3,0 p. m. to 4,30 p. m. Needle No. 1. Observer C. Wille.

Result. — $\theta = 72^\circ\ 24.'3$.

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2. Husø.

$\varphi = 60^\circ\ 59.'6$; $\lambda = 4^\circ\ 37'$ E. Greenwich.

a. Teltplads paa Øen, hvor Hr. Lexaus Hus staar.

Deklination. 1876, Juni 10, fandtes ved korresponderende Højder af Prof. Mohn[1] Kronometret Mewes 575 at være $0^h\ 28^m\ 30^s$ foran Stedets Middeltid og dets daglige Acceleration 5.'93.

Samme Dags Eftermiddag bestemtes fra Teltpladsen Azimut af "Poldetind", en Fjeldtop med Varde paa Indre Sulen, der ligger i en Afstand af 18.57 Kilometer fra Husø. Der observeredes i 3 Satser (I, II og III) med Cirkelens Nulpunkt i 3 forskjellige Stillinger, og i hver Sats Omlægning af Kikkerten gjennem Zenit (1 og 2). O = Object = Poldetinds Varde. ☉ = Cirkelaflæsning for Solens Centrum. Ch. = Kronometertid. ☉ = Foran-gaaende Solrand. ☉ = Efterfølgende Solrand. U = Uhrkorrektion. M. T. = Middeltid. E = Tidsjevning. t = Sand Soltid. δ = Solens Deklination. φ = Bredden. a = Solens Azimut. N. P. = Cirkelens Nordpunkt. A = Azimut af Objektet.

[1] H. Mohn. Astr. Obs., Side 5.

2. Husø.

$\varphi = 60^\circ\ 59.'6$; $\lambda = 4^\circ\ 37'$ E. Greenwich.

a. Tent on the main island, where Mr. Lexau's house stands.

Declination. — On the 10th of June, 1876, Professor Mohn[1] found the error of the chronometer, Mewes, No. 575, from equal altitudes, to be $0^h\ 28^m\ 30^s$ fast on local mean time, and its daily acceleration 5.'93.

In the afternoon of the same day, the azimuth of "Poldetind," a mountain-top with a trigonometrical signal, on the island of Indre Sulen, distant from Husø 18.57 kilometres, was determined from the tent. We observed in three sets (I, II, and III), with the zero-point of the horizontal circle in three different positions, and for each set reversing the telescope through the zenith (1 and 2). O = object = Poldetind signal; ☉ = reading of limb corresponding to the sun's centre; Ch = time by chronometer; ☉ = preceding solar limb; ☉ = following solar limb; U = error of chronometer; M. T. = mean time; E = equation of time; t = apparent solar time; δ = declination of sun; φ = latitude; a = azimuth of sun; N. P. = circle reading corresponding to the astronomical meridian (North Point); A = azimuth of object.

[1] H. Mohn. Astronomical Observations, p. 5.

	I 1	I 2	I M.	II 1	II 2	II M.	III 1	III 2	III M.
O.	165° 7.′1	7.′5	165° 7.′3	44° 55.′5	55.′0	44° 55.′25	284° 32.′0	31.′25	284° 31.′6
⊙	46 16.5	67.5	46 42.0	289 52.5	104.5	290 18.5	173 15.0	71.25	173 43.1
Ch. ⊙	7^h 3^m $0^s.5$	7^m $3^s.5$	7^h 5^m $2^s.0$	7^h 21^m $26^s.0$	25^m $32^s.5$	7^h 23^m $29^s.2$	7^h 39^m $31^s.5$	44^m $9^s.0$	7^h 41^m $50^s.3$
„ ⊙	5 38.3	9 41.5	7 39.9	24 4.2	28 9.4	26 6.8	42 7.0	46 43.7	44 25.3
Ch.			7^h 6^m $20^s.95$			7 24 48.0			7 43 7.8
U.			— 0 28 31.53			— 0 28 31.6			— 0 28 31.7
M. T.			6 37 49.4			6 56 16.4			7 14 36.1
E.			+ 44.0			+ 43.9			+ 43.9
t			6 38 33.4			6 57 0.3			7 15 20.0
δ			23° 4′ 20″			23° 4′ 20″			23° 4′ 20″
φ			60 59 36			60 59 36			60 59 36
a			N 70 18.′0 W			N 66 28.′7 W			N 62 41.′0 W
⊙			46 42.0			290 18.5			173 43.1
N. P.			117 0.0			356 47.2			236 24.1
O.			165 7.3			44 55.2			284 31.6
A.			N 48° 7.3 E			N 48° 8.′0 E			N 48° 7.′5 E

Azimuth of Poldetind = N 48° 7.′6 E.

Samtidig maaltes Horizontalvinkelen mellem Poldetind og Gavlen af et Hus med Theodoliten og fandtes = 130° 50.′1. Altsaa bliver Azimut af Gavlen = N 178° 57.′7 E eller S 1° 2.′3 E.

The horizontal angle between Poldetind and the gable of a house, was measured at the same time with the theodolite, and found to be 130° 50.′1. Hence, the azimuth of the gable = N 178° 57.′7 E, or S 1° 2.′3 E.

Klokkeslet. (Hour.)	Magnet I.	Gavl. (Gable.)	Diff.	Magnet II.	Gavl. (Gable.)	Diff.	M.	Decl.
3^h 20^m p. m.	278° 39′	295° 44′	17° 5′	278° 27′	295° 46.′5	17° 20′	17° 12.′5	18° 14.′8
7 30 „ „	218 13	235 22	17 9	217 49	235 22	17 33	17 21.0	18 23.3
5^h 25^m p. m.								18° 19.′

Den 13de Juni tog Prof. Mohn følgende Observationer til Bestemmelse af Deklinationen, paa samme Tid som jeg svang Skibet for at bestemme Compassernes Deviation. Stativet med Theodoliten rykkedes 0.75 Meter mod Sydsydost fra den forrige Plads. Herved bliver Azimut af Poldetind fra den nye Plads 0.′1 mindre, eller N 48° 7.′5 E.

Magnetometret opstilledes paa sin Plads og der gjordes følgende Observationer, med Instrumentets egen Kikkert, for at bestemme Magnet-Axens Collimation.

On the 13th of June, Professor Mohn took the following observations to determine the declination, whilst I swung the ship for deviation of compass. The theodolite and stand was now moved 0.75 metre south-south-east from its former position. Taken from this point, the azimuth of Poldetind will be 0.′1 less, or N 48° 7.′5 E.

After mounting the magnetometer, he took the following observations, with the telescope of the instrument, to determine the collimation of the axis of the magnet: —

Magnet I.	Magnet II.
79° 27′ 20″	79° 6′ 35″
28 35	7 30
27 35	
M. 79° 27′ 50″	79° 7′ 2.″5

½ Diff. = 10′ 24″ = 10.′4

Med Theodoliten toges følgende Observationer.

With the theodolite he took the following observations: —

Klokkeslet. (Hour.)	Magnet II.	Poldetind.	Declination.
22^h 34^m	266° 33′	153° 19′	18° 28′ W.
54	43	19	18
23 11	41	—	20
53	40	19.5	20
0 28	48	17.5	12
31	44.5	—	16
53	51	18	9
1 5	48	17	11
32	44	—	15
51	42	—	17
3 55	44	17	15
4 17	46	17	13
27	47	17	12
54	48	17.5	12
5 5	49	—	10
22	50	—	9
37	49.5	17	9
59	50	—	9
6 16	51	17.5	9
49	53	—	6

Ved grafisk Udjevning findes følgende Værdier for Deklinationen.

Computed from diagramatic interpolation, the following values were found for the declination: —

22^h 30^m	18° 25	1^h 30^m	18° 15′	4^h 30^m	18° 12′
23 0	22	2 0	17	5 0	11
23 30	19	2 30	19	5 30	10
0 0	17	3 0	18	6 0	9
0 30	13	3 30	16	6 30	8
1 0	12	4 0	15	7 0	7

og saaledes i Middel for Kl. 2.45^m Deklination = 18° 14.′7 W.

and thus, as a mean for 2.45 p. m. the declination is 18° 14.′7 W.

Horizontal-Intensitet.

1876, Juni 10.

Afbøjnings-Observation. Kl. 5 5 Min. Eft. til 6.0 Min. E. $t_0 = 50.°5$; $r_0 = 1$, $u_0 = 29° \ 30' \ 47''$; $r_0' = 1.3$, $u_0' = 12° \ 49' \ 35''$. C. Wille.

Svingnings-Observation. Kl. 4.3 Min. Eft. til 4.15 Min. Eft.

$t_0 = 52.°1$, $T_0 = 4.ˢ52585$; $s = 4.ˢ88$; $\alpha = 76'$; $\alpha' = 19'$; $u = 12.'82$. C. Wille.

Resultat. $P = 0.022999$; $m = 0.76534$; $X = 3.1732$.

1876, Juni 15.

Svingnings-Observation. Kl. 12.15 Min. til 12.27 Min. Eft.

$t_0 = 56.°8$; $T_0 = 4.ˢ53062$; $s = 4.ˢ9$; $\alpha = 50$ $\alpha' = 31'$, $u = 12.'51$. H. Mohn.

Afbøjnings-Observation. Kl. 1.20 Min. til 1.45 Min. Eft.

$t_0 = 56.°2$: $u_0 = 29° \ 29' \ 40''$; $u_0' = 12° \ 48' \ 35''$. H. Mohn.

Resultat. $P = 0.02462$; $m = 0.76500$; $X = 3.1751$.

Svingnings-Observation. Kl. 2.4 Min. til 2.16 Min. Efterm.

$t_0 = 57.°2$, $T_0 = 4.ˢ52815$; $s = 4.ˢ9$; $\alpha = 72'$; $\alpha' = 22'$, $u = 10.'87$. H. Mohn.

Efter den foregaaende Afbøjnings-Observation beregnes $X = 3.1750$.

Svingnings-Observation. Kl. 6.6 Min. til 6.17 Min. Efterm.

$t_0 = 54.°8$, $T_0 = 4.ˢ52880$; $s = 4.ˢ9$; $\alpha = 57'$; $\alpha' = 19'$; $u = 9.'03$. H. Mohn.

Efter den foregaaende Afbøjnings-Observation beregnes $X = 3.1746$

1877, Juni 4.

Afbøjnings-Observation. Kl. 4.0 Min. til 4.55 Min. Efterm.

$t_0 = 52.°9$; $u_0 = 28° \ 37' \ 12.''5$; $u_0' = 12° \ 27' \ 27.''5$. C. Wille.

Svingnings-Observation. Kl. 6.57 Min. til 7.8 Min. Efterm.

$t_0 = 48.°8$; $T_0 = 4.ˢ5902$; $s = 2.ˢ8$; $\alpha = 74'$; $\alpha' = 26'$; $u = 3.'99$. C. Wille.

Resultat. $P = 0.02433$; $m = 0.74415$; $X = 3.1761$.

Inklination.

1876, Juni 12. Kl. 10.30 Min. til 11.45 Min. Form. Naal No. 1. C. Wille.

$\theta = 72° \ 43.'35$.

Samme Dag. Kl. 1.30 Min. til 2.5 Min. Eft. Naal No. 2. C. Wille.

$\theta = 72° \ 40.'96$.

Horizontal Intensity.

1876, June 10.

Observation of Deflection: — 5.5 p. m. to 6.0 p m. $t_0 = 50.°5$; $r_0 = 1$; $u_0 = 29° \ 30' \ 47''$; $r_0' = 1.3$; $u_0' = 12° \ 49' \ 35''$. C. Wille.

Observation of Vibration: — 4.3 p. m. to 4.15 p. m.

$t_0 = 52.°1$, $T_0 = 4.ˢ52585$; $s = 4.ˢ88$; $\alpha = 76'$; $\alpha' = 19'$; $u = 12.'82$. C. Wille.

Result. — $P = 0.022999$; $m = 0.76534$; $X = 3.1732$.

1876, June 15.

Observation of Vibration: — 12.15 p. m. to 12.27 p. m.

$t_0 = 56.°8$; $T_0 = 4.ˢ53062$; $s = 4.ˢ9$; $\alpha = 50'$, $\alpha' = 31$, $u = 12.'51$. H. Mohn.

Observation of Deflection: — 1.20 p. m. to 1.45 p. m.

$t_0 = 56.°2$; $u_0 = 29° \ 29' \ 40''$, $u_0' = 12° \ 48' \ 35''$. H. Mohn.

Result. — $P = 0.02462$; $m = 0.76500$; $X = 3.1751$.

Observation of Vibration: — 2.4 p. m. to 2.16 p. m.

$t_0 = 57.°2$; $T_0 = 4.ˢ52815$; $s = 4.ˢ9$; $\alpha = 72'$; $\alpha' = 22'$, $u = 10.'87$. H. Mohn.

Computed from the preceding observation of deflection $X = 3.1750$.

Observation of Vibration: — 6.6 p. m. to 6.17 p. m.

$t_0 = 54.°8$; $T_0 = 4.ˢ52880$; $s = 4.ˢ9$; $\alpha = 57'$; $\alpha' = 19'$; $u = 9.'03$. H. Mohn.

Computed from the preceding observation of deflection $X = 3.1746$.

1877, June 4.

Observation of Deflection: — 4.0 p. m. to 4.55 p. m.

$t_0 = 52.°9$; $u_0 = 28° \ 37' \ 12.''5$; $u_0 = 12° \ 27' \ 27.''5$. C. Wille.

Observation of Vibration: — 6.57 p. m. to 7.8 p m.

$t_0 = 48.°8$; $T_0 = 4.ˢ5902$; $s = 2.ˢ8$; $\alpha = 74'$; $\alpha' = 26'$; $u = 3.'99$. C. Wille.

Result. — $P = 0.02433$; $m = 0.74415$; $X = 3.1761$.

Inclination.

1876, June 12: — 10.30 a. m. to 11.45 a. m. Needle No. 1. C. Wille.

$\theta = 72° \ 43.'35$.

Same Day: — 1.30 p. m. to 2.5 p. m. Needle No. 2. C. Wille.

$\theta = 72° \ 40.'96$.

Samme Dag. Kl. 6.15 Min. til 7.5 Min. Eft. Naal No. 1. C. Wille.

$\theta = 72° 43.'9.$

1876, Juni 15. Kl. 10.55 Min. til 11.53 Min. Form. Naal No. 1. H. Mohn.

$\theta = 72° 46.'02.$

Samme Dag. Kl. 7.7 Min. til 7.32 Min. Eft. Naal No. 2. H. Mohn.

$\theta = 72° 45.'05.$

1877, Maj 23. Kl. 5.0 Min. til 6.45 Min. Eft. Naal No. 1. C. Wille.

$\theta = 72° 43.'35.$

Same Day: — 6.15 p. m. to 7.5 p. m. Needle No. 1. C. Wille.

$\theta = 72° 43.'9.$

1876, June 15: — 10.55 a. m. to 11 53 a. m. Needle No. 1. H. Mohn.

$\theta = 72° 46.'02.$

Same Day: — 7.7 p. m. to 7.32 p. m. Needle No. 2. H. Mohn.

$\theta = 72° 45.'05.$

1877, May 23: — 5.0 p. m. to 6.45 p. m. Needle No. 1. C. Wille.

$\theta = 72° 43.'35.$

β. Et Skjær paa Østsiden af Havnen.

Deklination. Juni 16. Iagttager: Professor Mohn.

Fra det Punkt, hvor Theodoliten var opstillet foran Magnetometret, kunde Poldetind ikke sees paa Grund af, at et nærmere liggende Fjeld kom i Vejen. Men fra et nærliggende Punkt paa Skjæret, i SSE for det første, vár Poldetind synlig. Paa Øen, hvor Teltet stod, saaes Poldetind i samme Vertikal som Observationspunktet paa Skjæret, naar Theodoliten flyttedes, lodret paa Synslinien til Poldetind, 41.4 Meter mod SE fra Observationspunktet i Teltet. Heraf beregnes, at Azimut af Poldetind, seet fra Theodolitens Plads paa Skjæret, var

48° 7.'6 — 7.'7 = 47° 59.'9 E.

Fra den søndre Ende af Skjæret saaes en anden fjern Fjeldtop 10° 25′ nordenfor Poldetind. Fra Observationspunktet paa Skjæret saaes Varden paa Husø 182° 27′ til venstre for den nævnte Fjeldtop. Vinkelen mellem Husø Varde (i SW) og Poldetind (i NE) regnet over Nord var følgelig 192° 52′. Da Poldetinds Azimut var N 48° 0′ E, bliver Azimut af Husø Varde:

β. An Islet at the east side of the Harbour.

Declination. June 16. Observer Professor Mohn.

From the point at which the theodolite was mounted in front of the magnetometer, Poldetind could not be sighted, a mountain in the vicinity intercepting the view in that direction. Poldetind was visible however from an adjacent point south-south-east of the former. From the island on which was pitched the tent, Poldetind could be sighted in the same vertical as the point of observation on the islet, after moving the theodolite, perpendicular to the line of vision, 41.4 metres south-east of the point of observation in the tent. Hence, the azimuth of Poldetind as observed from the position of the theodolite on the islet, was —

48° 7.'6 — 7.'7 = N 47° 59.'9 E

From the southern extremity of the islet could be seen another distant mountain-top, 10° 25′ north of Poldetind. Sighted from the point of observation on the islet, Husø signal was 182° 27′ to the left of that summit. The angle between Husø signal (bearing SW.) and Poldetind (bearing NE.) reckoned through the north, was accordingly 192° 52′. The azimuth of Poldetind being N 48° 0′ E, that of Husø signal is —

192° 52′ — 48° 0′ = N. 144° 52′ W = S 35° 8′ W.

Kl. 11.15 Min. Form. gjordes følgende Observationer:

At 11.15 a. m. the following observations were made: —

Magnet	I 159° 31′	II 339° 3′	I 159° 4′	II 158° 50′
Husø Varde (*Husø Signal*)	213 30	393 30	213 30	213 30
Vinkel (*Angle*)	53 59	54 27	54 26	54 40
Middel (*Mean*)			S 54° 8′ W	
Azimut af Husø Varde (*Azimuth of Signal*)			S 35 8 W	
Declination			19° 0′ W	

Om Eftermiddagen opstilledes Instrumenterne paa Skjæret paa en anden Plads, i Nærheden af den forrige. Da Solen var synlig, benyttedes den til Azimutbestemmelse.

In the afternoon the instruments were set up at a point on the islet near to that previously selected. The sun being visible, the azimuth was found from solar observations.

Ch. ⊙	$7^h\ 41^m\ 50.^s$	$46^m\ 17.^s5$	$7^h\ 44^m\ 3.^s75$	Magnet I	7° 23.'75
„ ⊙	44 23.5	48 52.7	46 38.1	— II	57.0
			7 45 20.9	— I	37.0
U.			— 0 29 6.1	Magnet	7° 43.'7
M. T.			7 16 14.8	Magnet	187° 43.'7 — 180°
E.			— 31.3	N. P.	205 45.3
t			7 15 43.5	Decl.	18° 1.'6 W.
a			N 62° 26.'8 W.		
⊙			143 18.5		
N. P.			205 45.3		

Horizontal-Intensitet.

1876. Juni 16.

Afbøjnings-Observation. Kl. 12.5 Mm. til 12.37 Min. Eft.

$t_0 = 53.^0 8$; $u_0 = 29^0\ 30'\ 52.''5$; $u_0' = 12^0\ 50'\ 25.''6$. H. Mohn.

Svingnings-Observation. Kl. 1.0 Min til 1.10 Min. Eft.

$t_0 = 60.^0 5$; $T_0 = 4.5331$; $s = 4.'9$; $\alpha = 33'$; $\alpha' = 7'$; $u = 5.'21$. H. Mohn.

Resultat: $P = 0.02075$; $m = 0.76655$; $X = 3.1686$.

Afbøjnings-Observation. Kl. 2.0 Mm. til 2.20 Mm. Eft.

$t_0 = 53.^0 8$; $u_0 = 29^0\ 25'\ 1''$. H. Mohn.

Beregnet efter foregaaende Svingnings-Observation faaes $m = 0.7654$ og $X = 3.1734$.

Horizontal Intensity.

1876. June 16.

Observation of Deflection: — 12.5 p. m. to 12.37 p. m.

$t_0 = 53.^0 8$; $u_0 = 29^0\ 30'\ 52.''5$; $u_0' = 12^0\ 50'\ 25.''6$. H. Mohn.

Observation of Vibration: — 1.0 p. m. to 1.10 p. m.

$t_0 = 60.^0 5$; T_0 4.5331; $s = 4.'9$; $\alpha = 33'$; $\alpha' = 7'$; $u = 5.'21$. H. Mohn.

Result: — $P = 0.02075$; $m = 0.76655$; $X = 3.1686$.

Observation of Deflection: — 2.0 p. m. to 2.20 p. m.

$t_0 = 53.^0 8$; $u_0 = 29^0\ 25'\ 1''$. H. Mohn.

Computed from the preceding observation of vibration $m = 0.7654$ and $X = 3.1734$.

Inklination.

1876. Juni 16.

Kl. 6.10 Min. til 6.49 Min. Eft. Naal No. 1. H. Mohn.
$\theta = 72^0\ 44.'8$.

Inclination.

1876. June 16.

6.10 p. m. to 6.49 p. m. Needle No 1. H. Mohn.
$\theta = 72^0\ 44.'8$.

3. Reykjavik.

$\varphi = 64^0\ 8'\ 30''$; $\lambda = 21^0\ 54'\ 8''$ V. Greenwich.

Den grønne Plæne ved Konsul Simons Hus.

Deklination. 1876. Aug. 1ste fandt jeg ved corresponderende Højder af Solen, at Kronometret Kullberg viste $2^h\ 6^m\ 55.^s6$ foran Stedets Middeltid ved Middag[1]. Kronometret vandt daglig $0.^s60$.

Den 29de Juli om Eftermiddagen bestemte jeg Azimut af en Mire.

[1] Se H. Mohn. Astr. Obs. Side 6.

3. Reykjavik.

$\varphi = 64^0\ 8'\ 30''$; $\lambda = 21^0\ 54'\ 8''$ W. Greenwich.

The grass-plot adjoining Mr. Simson's house.

Declination. 1876. Aug. 1st I found the Kullberg chronometer, from equal solar altitudes[1], to be at noon $2^h\ 6^m\ 55.^s6$ fast on mean local time; chronometer gaining daily $0.^s60$.

On the 29th of July, after noon, I determined the azimuth of a mark.

[1] See H. Mohn. Astronomical Observations, p. 6.

	1		2		M.			5ʰ 30ᵐ p. m. Magnet.	Mire. (Mark.)
O.	95°	10.′0		9.′5	95°	9.′75	I	21° 34.′0	95° 9.′5
⊙	149	54.0	150	42.5	150	18.25	II	22 34.5	95 10.0
Ch. ⊙	7ʰ 32ᵐ	5.′5	35ᵐ	46.′0	7ʰ 33ᵐ	55.75	I	21 37.5	95 10 0
„ ⊙	34	41.5	38	19.5	36	30.50		22° 5.′1	95° 9.′8

	7ʰ 35ᵐ	13.′1
U.	− 2 6	54.2
M. T.	5 28	18.9
E.	— 6	10.7
t	5 22	8.2
a	N 90°	5.′4 W.
⊙	150	18.25
N. P.	240	23.65
O.	95	9.75
A.	N 145	13.9 W.

A	=	N 145° 13.′9 W
Mire	=	95 9.8
N P	=	240 23.7
Magnet	=	202 5.1 — 180°
Decl.	=	38° 18.′6 W.

Horizontal-Intensitet.

1876. Juli 31,

Afbøjnings-Observation. Kl. 10 til 11 Form.

$t_0 = 55.°0$; $u_0 = 36° 26' 45''$; $u_0' = 15° 31' 55''$. C. Wille.

Svingnings-Observation. Kl. 12.6 Min. til 12. 18 Min. Eft.

$t_0 = 57.°5$; $T_0 = 5.'0050$; $s = 0.'60$; $a = 76'$; $a' = 23'$; $u = 10.'4$. C. Wille.

Resultat: P = 0.02231; m = 0.76147; X = 2.6141.

Svingnings-Observation. Kl. 3.57 Min. til 4.10 Min. Eft.

$t_0 = 57.°8$; $T_0 = 4.'9810$; $s = 0.'60$; $a = 76'$; $a' = 23'$; $u = 8.'5$. C. Wille.

Afbøjnings-Observation. Kl. 5.10 Min. til 6.10 Min. Eft.

$t_0 = 57.°0$; $u_0 — 35° 59' 22''$. C. Wille.

Resultat: Med P = 0.02231; m = 0.7612; X = 2.6407.

Inklination.

1876. Juli 28. Kl. 5.0 til 6,35 Eft. Naal No. 1. C. Wille.

$\theta = 76° 28.'5$.

1876. August 1. Kl. 1.20 Min. til 2.20 Min. Eft. Naal No, 2. C. Wille.

$\theta = 76° 26.'3$.

Horizontal Intensity.

1876. July 31.

Observation of Deflection: — 10 a. m. to 11 a. m.

$t_0 = 55.°0$; $u_0 = 36° 26' 45''$; $u'_0 = 15° 31' 55''$. C. Wille.

Observation of Vibration: — 12.6 p. m. to 12.18 p. m.

$t_0 = 57.°5$; $T_0 = 5.'0050$; $s = 0.'60$; $a = 76'$; $a' = 23'$; $u = 10.'4$. C. Wille.

Result: — P = 0.02231; m = 0.76147; X = 2.6141.

Observation of Vibration: — 3.57 p. m. to 4.10 p. m.

$t_0 = 57.°8$; $T_0 = 4.'9810$; $s = 0.'60$; $a = 76'$; $a' = 23'$; $u = 8.'5$. C. Wille.

Observation of Deflection: — 5.10 p. m. to 6.10 p. m.

$t_0 = 57.°0$; $u_0 = 35° 59' 22''$. C. Wille.

Result: — With P = 0.02231; m = 0.7612; X = 2.6407.

Inclination.

1876. July 28: — 5.0 p. m. to 6.35 p. m. Needle No. 1. C. Wille.

$\theta = 76° 28.'5$.

1876. Aug. 1: — 1.20 p. m. to 2.20 p. m. Needle No. 2. C. Wille.

$\theta = 76° 26.'3$.

4. Namsos.

$\varphi = 64^\circ\ 28'\ 12''$ $\lambda = 11^\circ\ 31'\ 33''$ E. Greenwich.

Ved Bunden af Bugten nordenfor Byen, c. 7 Meter fra Stranden, strax søndenfor Stien, der fører videre til en Grind.

Declination. 1876. August 19 fandt Prof. Mohn ved corresponderende Højder af Solen[1] Kronometret Frodshams Korrektion til Stedets Middeltid lig $+\ 0^h\ 31^m\ 47.^s85$. Kronometret vandt daglig $5.^s12$.

Den 18de August om Eftermiddagen gjorde vi begge i Forening Observationer til Bestemmelse af Azimut og Deklination.

4. Namsos.

$\varphi = 54^\circ\ 28'\ 12''$ $\lambda = 11^\circ\ 31'\ 33''$ E. Greenwich.

At the head of the bay, north of the town, about 7 metres from the shore, and directly south of the pathway leading to a gate.

Declination. 1876. Aug. 19 Professor Mohn found, from equal solar altitudes,[1] the error of the Frodsham chronometer on mean local time $= 0^h\ 31^m\ 47.^s85$; chronometer gaining daily $5.^s12$.

On the 18th of August, in the afternoon, Professor Mohn and myself took observations to determine the azimuth and declination.

Ch. ⊙|	$5^h\ 47^m\ 54^s$	$51^m\ 53^s$	$5^h\ 49^m\ 53.^s5$	Magnet I	$98^\circ\ 26'$
„ |⊙	50 18	54 17	52 17.5	— II	99 0
			5 51 5.5	— I	98 26
U.			+ 31 51.7		98° 43
M. T.			6 22 57.2	Magnet	$278^\circ\ 43.'0 - 180^\circ$
E.			— 0 3 29.2	N. P.	292 25.9
t			6 19 28.0	Decl.	$13^\circ\ 42.'9$ W.
a			N $80^\circ\ 2.'9$ W.		
⊙			212 23.0		
N. P.			292 25.9		

Horizontal-Intensitet.

1879. Aug. 18.

Afbøjnings-Observation. Kl. 11.30 Min. Form. til 12.50 Min. Eft.

$t_o = 67.^\circ3$; $u_o = 31^\circ\ 29'\ 42''$; $u_o' = 13^\circ\ 35'\ 40''$. C. Wille.

Svingnings-Observation. Kl. 1.51 Min. til 2.3 Min. Eft.

$t_o = 70.^\circ7$; $T_o = 4.^s7183$; $s = 5.^s12$; $\alpha = 76'$; $\alpha' = 24'$; $u = 4.'1$. C. Wille.

Resultat: P = 0.02671; m = 0.75760; X = 2.9639.

Inklination.

1876. August 19. Kl. 10.30 Min. til 11.30 Form. Naal No. 1. C. Wille.

$\theta = 74^\circ\ 2.'3.$

Samme Dag. Kl. 5.0 Min. til 6.0 Min. Eft. Naal No. 2. H. Mohn.

$\theta = 74^\circ\ 2.'3.$

Horizontal Intensity.

1876. Aug. 18.

Observation of Deflection: — 11.30 a. m. to 12.50 p. m.

$t_o = 67.^\circ3$; $u_o = 31^\circ\ 29'\ 42''$; $u_o' = 13^\circ\ 35'\ 40''$. C. Wille.

Observation of Vibration: — 1.51 p. m. to 2.3 p. m.

$t_o = 70.^\circ7$; $T_o = 4.^s7183$; $s = 5.^s12$; $\alpha = 76'$; $\alpha' = 24'$; $u = 4.'1$. C. Wille.

Result: — P = 0.02671; m = 0.75760; X = 2.9639.

Inclination.

1876. Aug. 19: — 10.30 a. m. to 11.30 a. m. Needle No. 1. C. Wille.

$\theta = 74^\circ\ 2.'3.$

Same Day: — 5.0 p. m. to 6.0 p. m. Needle No. 2. H. Mohn.

$\theta = 74^\circ\ 2.'3.$

[1] H. Mohn. Astr. Obs. Side 7.

[1] H. Mohn. Astronomical Observations, p. 7.

5. Bodø.

$\varphi = 67°\ 17'\ 14''$ $\lambda = 14°\ 24'\ 51''$ E. Greenwich.

I Nærheden af Stranden, noget østenfor den østligste Landgangsbrygge.

1877. August 13 observerede Prof. Mohn Solhøjder samtidig med at jeg tog de magnetiske Observationer[1]. Ved de første fandtes umiddelbart Standen af Kronometret Frodsham for Stedets sande Tid (U').

5. Bodø.

$\varphi = 67°\ 17'\ 14''$ $\lambda = 14°\ 24'\ 51''$ E. Greenwich.

Near the shore, a little to the east of the most easterly landing-pier.

1877. Aug. 13 Professor Mohn observed altitudes of the sun, whilst I took magnetic observations[1]. By direct computation from the altitudes, he determined the error of the Frodsham chronometer on apparent local time (U').

Deklination. *Declination.*

1877. August 13.

Ch.	☉	5^h	59^m	$5.^s5$	6^h	4^m	$22.^s0$	6^h	1^m	$43.^s75$	Magnet I	80°	41.'5	
„	☉	6	1	27.0	6	4	46.0		+	6.50	— II	80	13.6	
								6	2	55.1		80	27.55	
U'								— 0	1	57.8				
											Magnet	260	27.55	— 180°
t								6	0	57.3	N. P.	272	8.7	
a								N 84°	4.'5	W.	Decl.	11°	41.'2	W.
☉								188	34.2					
N. P.								272	8.7					

Horizontal-Intensitet.
1877. Aug. 13.

Svingnings-Observation. Kl. 12.10 Min. til 12.23 Min. Eft.

$t_0 = 77.°6$; $T_0 = 4.^s9275$; $s = 3.'4$; $a = 76'$; $a' = 25'$; $u = 3.'4$. C. Wille.

Afbøjnings-Observation. Kl. 4.30 Min. til 5.30 Min. Eft.

$t_0 = 72.°7$; $u_0 = 32°\ 46'\ 20''$; $u_0' = 14°\ 6'\ 35''$. C. Wille.

Resultat: P $= 0.02445$; $m = 0.74020$; X $= 2.7854$.

Inklination.

1877. August 13. Kl. 9.45 Min. til 11.10 Min. Form. Naal No. 1. C. Wille.

$\theta = 75°\ 21.'4$

Horizontal Intensity.
1877. Aug. 13.

Observation of Vibration: — 12.10 p. m. to 12.23 p. m.

$t_0 = 77.°6$; $T_0 = 4.^s9275$; $s = 3.'4$; a 76'; $a' = 25'$; $u = 3.'4$. C. Wille.

Observation of Deflection: — 4.30 p. m. to 5.30 p. m.

$t_0 = 72.°7$; $u = 32°\ 46'\ 20''$; $u_0' = 14°\ 6'\ 35''$. C. Wille.

Result: — P $= 0.02445$; $m = 0.74020$; X $= 2.7854$.

Inclination.

1877. August 13: 9.45 a. m. to 11.10 a. m. Needle No. 1 C. Wille.

$\theta = 75°\ 21.'4$.

6. Tromsø.

$\varphi = 69°\ 39.'1$ $\lambda = 18°\ 59.'3$ E. Greenwich.

Ved Stranden, nogle hundrede Skridt nordenfor Bryggen ved Storstennes, paa Østsiden af Tromsø-Sundet.

Bredde og Længde efter de norske Kystkarter. Kronometrets, Frodshams, Stand for Stedets Tid er beregnet efter dets Stand for Greenwich Tid og Kartets Længde.

6. Tromsø.

$\varphi = 69°\ 39.'1$ $\lambda = 18°\ 59.'3$ E. Greenwich.

On the beach, a few hundred paces north of the landing-pier at Storstennes, on the east side of Tromsø Sound.

Latitude and longitude from the coastal charts. Error of chronometer (Frodsham) on local time computed from error on Greenwich time and the longitude of the chart.

[1] H. Mohn. Astr. Obs. Side 8.

[1] H. Mohn. Astronomical Observations, p. 8.

Deklination. *Declination.*

1877. Juli *(July)* 11.

Ch. ⊙	6^h 24^m $4.^s0$	29^m $56.^s5$		6^h 27^m $0.^s25$	Magnet I	80° $10.'25$
„ ⊙	26 36.0	32 28.0		29 32.0	— II	80 20.5
				6 28 16.1		80 15.4
U.			+	22 56.0	Magnet	260° $15.'4$ — 180°
M. T.				6 51 12.1	N. P.	270 33.1
E.			—	0 5 14.5	Decl.	10 17.7 W.
t				6 45 57.6		
a			N	71° $30.'9$ W		
⊙				199 2.2		
N. P.				270 33.1		

Horizontal-Intensitet.

1877. Juli 11.

Svingnings-Observation. Kl. 4.2 Min. til 4.16 Min. Eft. $t_0 = 56.^\circ4$; $T_0 = 5.^s0459$; $s = 3.^s4$; $\alpha = 74'$; $\alpha' = 21'$; $u = 5.'7$. C. Wille.

Afbøjnings-Observation. Kl. 5.35 Min. til 6.13 Min. Eftm.

$t_0 = 56.^\circ6$; $u_0 = 35^\circ\ 0'\ 35''$; $u_0' = 14^\circ\ 59'\ 37.''5$. C. Wille.

Resultat: $P = 0.02142$; $m = 0.74260$; $X = 2.6365$.

Inklination.

1877. Juli 11. Kl. 11.40 Min. Form. til 12.45 Min. Eft. Naal No. 1. C. Wille.

$\theta = 76^\circ\ 21.'85$.

Horizontal Intensity.

1877. July 11.

Observation of Vibration: — 4.2 p. m. to 4.16 p. m. $t_0 = 56.^\circ4$; T_0 $5.^s0459$; $s = 3.^s4$; $\alpha = 74'$; $\alpha' = 21'$; $u = 5.'7$. C. Wille.

Observation of Deflection: — 5.35 p. m. 6.13 p. m.

$t_0 = 56.^\circ6$; $u_0 = 35^\circ\ 0'\ 35''$; $u_0' = 14^\circ\ 59'\ 37.''5$. C. Wille.

Result: — $P = 0.02142$; $m = 0.74260$; $X = 2.6365$

Inclination.

1877. July 11: — 11.40 a. m. to 12.45 p. m. Needle No. 1. C. Wille.

$\theta = 76^\circ\ 21.'85$.

7. Hammerfest.

$\varphi = 70^\circ\ 40'\ 11''$ $\lambda = 23^\circ\ 40'\ 26''$ E. Greenwich.

Paa Fuglenes, i Nærheden af Meridianstotten. Tidsbestemmelse ved Solhøjder af Prof. Mohn den 9de og 10de Juli 1878.[1]

Deklination.

1878. Juli 9 om Eftermiddagen bestemte vi Azimut af Kirkespiret. Observationsuhr Lommekronometer, hvis Korrektion til Stedets sande Tid var funden = + $51^m\ 20.^s4$.

Den 10de Juli Kl. 12.35 Min. Eft., bestemte jeg Deklinationen.

[1] H. Mohn. Astr. Obs. Side 12—14.

7. Hammerfest.

$\varphi = 70^\circ\ 40'\ 11''$ $\lambda = 23^\circ\ 40'\ 26''$ E. Greenwich.

At Fuglenes, near by the arc of meridian terminus column. Error of chronometer found from altitudes of the sun, taken by Professor Mohn on the 9th and 10th of July, 1878.[1]

Declination.

1878. July 9, in the afternoon, we determined the azimuth of the church spire, observing with the pocket-chronometer, for which the error on local apparent time was found to be + $51^m\ 20.^s4$.

On the 10th of July, 12 35 p. m., I determined the declination.

[1] H. Mohn. Astronomical Observations, p. 12—14.

	O.		229°	9′		10.′0		229°	9.′5	
	⊙		18	41.5	19°	27.0		19	4.25	
Ch.	⊙	6^h	14^m	26.′4	17^m	46.′0	6^h	16^m	6.′2	
	⊙		16	50.0	20	15.0		18	32.5	
U′							6	17	19.35	
							+	51	20.4	
t							7^h	8^m	39.75	
a							N	66°	32.′5	W
⊙								19	4.25	
N. P.								85°	36.′75	
O.								229	9.5	
A.							N	143°	32.′75	E.

	Magnet.		Mire. (*Mark.*)		
I	80°	4.′0	48°	51.′5	
II	79	36.7	48	52.0	
	79	50.35	48	51.75	
A =		N	143°	32.′75	E.
Mire			48	51.75	
N. P.			265	19.0	
Magnet			259	50.35	— 180°
Decl.			5°	28.′6	W.

Horizontal-Intensitet.

Svingnings-Observation. 1878. Juli 9. Kl. 5.40 Min. til 5.52 Min. Eft.

$t_o = 55.°7$; $T_o = 5.^s0660$; $s = 7.'0$; $\alpha = 76'$; $\alpha' = 19'$; $u = 2.'49$. C. Wille.

Afbøjnings-Observation. 1878. Juli 10. Kl. 12.45 Min. til 1.30 Min. Eft.

$t_o = 64.°9$; $u_o = 37° \; 22' \; 9''$; $u_o' = 15° \; 54' \; 10''$. C. Wille.

Resultat: P = 0.01896; m = 0.7627;[1] X = 2.5484.

Inklination.

1878. Juli 10. Kl. 10.45 Min. til 11.55 Min. Form. Naal No. 1. C. Wille.

$\theta = 76° \; 54.'25$.

Horizontal Intensity.

Observation of Vibration. 1878. July 9: — 5.40 p. m. to 5.52 p. m.

$t_o = 55.°7$; $T_o = 5.^s0660$; $s = 7.'0$; $\alpha = 76'$; $\alpha' = 19'$; $u = 2.'49$. C. Wille.

Observation of Deflection. 1878. July 10: — 12.45 p. m. to 1.30 p. m.

$t_o = 64.°9$; $u_o = 37° \; 22' \; 9''$; $u_o' = 15° \; 54' \; 10''$. C. Wille.

Result: — P = 0.01866; m = 0.7627;[1] X = 2.5484.

Inclination.

1878. July 10: — 10.45 a. m. to 11.55 a. m. Needle No. 1. C. Wille.

$\theta = 76° \; 54.'25$.

8. Vardø.

$\varphi = 70° \; 22' \; 24''$ $\lambda = 31° \; 7' \; 51''$ E. Greenwich.

Paa Fæstningen Vardohus's Glacis. 170 Meter Nord for Fæstningens Midtpunkt.

Horizontal-Intensitet.

Svingnings-Observation. 1878. Juni 26. Kl. 1.4 Min. til 1.13 Min. Eft.

$t_o = 50.°4$; $T_o = 5.^s0418$; $s = 8.'0$; $\alpha = 72'$; $\alpha' = 28'$; $u = 4.'08$. C. Wille.

Afbøjnings-Observation. 1878. Juni 26. Kl. 5.10 Min til 6.5 Min. Eft.

$t_o = 47.°8$; $u_o = 37° \; 11' \; 12''$; $u_o' = 15° \; 48' \; 30''$. C. Wille.

Resultat: P = 0.02259; m = 0.7616 X = 2.5737.

Inklination.

1878. Juni 26. Kl. 10.40 Min. til 11.37 Min. Form. Naal No. 1. C. Wille.

$\theta = 76° \; 52.'4$.

8. Vardø.

$\varphi = 70° \; 22' \; 24''$ $\lambda = 31° \; 7' \; 51''$ E. Greenwich.

The glacis of Vardohus, 170 metres north of the centre of the fortress.

Horizontal Intensity.

Observation of Vibration. 1878. June 26: — 1.4 p. m. to 1.13 p. m.

$t_o = 50.°4$; $T_o = 5.^s0418$; $s = 8.'0$; $\alpha = 72'$; $\alpha' = 28'$; $u = 4.'08$. C. Wille.

Observation of Deflection. 1878. June 26: — 5.10 p. m. to 6.5 p. m.

$t_o = 47.°8$; $u_o = 37° \; 11' \; 12''$; $u_o' = 15° \; 48' \; 30''$. C. Wille.

Result: — P = 0.02259; m = 0.7616; X = 2.5737.

Inclination.

1878. June 26. 10.40 a. m. to 11.37 a. m. Needle No. 1. C. Wille.

$\theta = 76° \; 52.'4$.

[1] Magneten var i 1878 opmagnetiseret.

[1] The Magnet had been re-magnetised in 1878.

B. Observationer i Søen og deres Resultater.

Ved Expeditionens Udrustning var det paatænkt, at der skulde gjøres fuldstændige magnetiske Observationer ombord, naar man var i Søen. Hertil havdes fuldstændigt Apparat i Admiralitets Standard-Kompasset og Fox-Cirkelen. Med denne sidste foretog jeg i 1876, under Skibets Udrustning, paa Bergens Observatorium de nodvendige Afvejninger. Under Expeditionens Ophold i Husø fra den 10de til 19de Juni samme Aar gjordes alle de fornødne Basis-Observationer. De magnetiske Elementers Størrelse bestemtes, som ovenfor vist, i Land ved absolute Maalinger. Deviationen bestemtes saavel for Styre-Kompasset som for Fox-Cirkelens Plads og med Fox-Cirkelen maaltes Inklination og Intensitet under forskjellige anlagte Kurser, idet Skibet blev svunget ved Hjælp af Trosser. Der toges Svingnings-Observationer til Bestemmelse af Coefficienterne μ og λ.

Ved Beregningen af de med Fox-Cirkelen ombord maalte Inklinationer og Intensiteter, fandt Prof. Mohn, at disse ikke kunde bringes til indbyrdes Harmoni, med mindre Indexfejlen for Fox-Cirkelens Naal sattes hele 19 Minuter større, end den fandtes af de Observationer, der var gjorte i Land paa samme Sted og til samme Tid med Fox-Cirkelen og med Inklinatoriet.

Da vi den 22de Juni 1876 i meget roligt Vejr og rolig Sø forsøgte Observationer med Fox-Cirkelen, viste det sig, at Skibet, vel nærmest paa Grund af det langsomt virkende Styreapparat,[1] ikke kunde holdes paa Kurs med den Støhed, som udfordredes til at Observationerne kunde gjøres med nogenlunde Nøjagtighed, ligesom Skibets vertikale Bevægelser uagtet den rolige Sø viste sig yderst hindrende i samme Retning. Beregningen af Observationerne gav ogsaa et utilfredsstillende Resultat. Kun en Gang senere forsøgtes, nemlig under Sejladsen ind til Thorshavn, Observationer med Fox-Cirkelen. Det yderst urolige Vejr, som Expeditionen havde i 1876, forbød alle videre Forsøg i dette Aar.

I 1877 hindrede saavel Vejret, som den Omstændighed, at jeg maatte gaa fra Husø til Bergen for at faa indsat ny Mellemaxel i Maskinen, mig i at foretage Basis-Observationer. I 1878 var Expeditionen under Rejserne saa ganske optagen af andre mere nødvendige Gjøremaal, at der ikke levnedes Tid til at tage andre magnetiske Observationer ombord end til Bestemmelse af Misvisningen.

Saaledes forenede sig Skibets magnetiske Konstitution, om jeg saa maa kalde det, dets langsomtvirkende Styreapparat, dets Letbevægelighed og ringe Bredde, uroligt Vejr, Reparation af Maskinen og Hensynet til Expeditionens Hovedarbejder, Lodninger, Temperaturmaalinger og Skrabninger, til absolute Hindringer mod Fox-Cirkelens

[1] C. Wille. Apparaterne og deres Brug. Side 4.

B. Observations at Sea, and their Results.

The Scheme of Work approved for the Expedition included complete series of magnetic observations at sea, for which we had the Admiralty standard compass and the Fox circle. With the latter instrument, I undertook in 1876, at the Bergen Observatory, whilst the ship was fitting out, the necessary weighings. During the stay of the Expedition at Husø, from the 10th to the 19th of June, same year, were taken all necessary base-observations. The deviation was determined alike for the steering-compass and the position of the Fox circle, and inclination and intensity were observed with the Fox circle on different courses, the ship being swung the while by means of hawsers. Observations of vibration were taken to determine the coefficients μ and λ.

In his computations of inclination and intensity observed on board with the Fox circle, Professor Mohn could not, he found, attain satisfactory agreement for the respective results unless the index-error for the needle of the Fox circle were put as much as 19 minutes greater than the error found from the observations taken on shore in the same place and at the same time with the Fox circle and with the dip circle.

On taking a few preliminary observations with the Fox circle, June 22nd 1876, in very fine weather and a calm sea, it was found impossible, chiefly no doubt owing to the tardy action of the steering-apparatus,[1] to keep the ship sufficiently steady on her course for observing with comparative accuracy; moreover, the vertical motion of the vessel, calm as was the sea, proved a serious obstacle to the attainment of anything like trustworthy determinations. The computed results, too, were not to be relied upon. Only once afterwards, viz. when nearing Thorshavn, did we try to observe with the Fox circle; indeed the boisterous weather encountered by the Expedition throughout the summer of 1876, precluded any further attempt on the first cruise.

In 1877 I had no opportunity of taking base-observations, both by reason of the weather and the discovery, on arriving at Husø, of a defect in the engine-shaft, necessitating our immediate return to Bergen to get a new one put in. In 1878 the prosecution of other and more important exploratory work left no time for magnetic observations save those required to determine declination.

Thus, the ship's magnetic properties, so to speak, the slow action of her steering-apparatus, her great mobility and trifling breadth of beam, rough weather, time lost in repairing the engine, and regard to the main objects of the Expedition, viz. sounding, determining temperature, and dredging the bottom, — proved one with the other in-

[1] C. Wille. The Apparatus, and How Used, p. 4.

Anvendelse i Soen. Betingelser for dens heldige Anvendelse er et bredt Fartøj, en let Styring, roligt Vejr og tilstrækkelig Tid, samt fremfor alt en saadan Plads for Instrumentet, at de med samme tagne Bestemmelser af Inklination og Intensitet harmonerer.

Det er saaledes kun Misvisnings-Observationerne, der have ledet til brugbare Resultater.

Førend jeg gaar over til at beskrive den i Søen anvendte Fremgangsmaade og give de beregnede Resultater, maa jeg først omtale Resultaterne af de Observationer, som gjordes i Husø til Bestemmelse af Kompassets Deviation.

Den 13de Juni 1876 svang jeg Skibet paa Husø Havn for at bestemme Kompassets Deviation. Svingningen udførtes ved Trosser, fastgjorte i Land. For hver anlagt Kurs (16 forskjellige Streger), paa hvilke der observeredes, pejledes med Kompasset Varden paa Poldetind. Samtidig observerede paa Teltpladsen i Land Prof. Mohn, paa givet Signal, Magnetometret til Bestemmelse af den absolute Deklination. Fra Teltpladsen var, som ovenfor Side 8 anført, Azimut af Varden paa Poldetind N 48° 7.'5 E. Da Fartøjet (Standard Kompasset ombord) under Svingningen laa meget nær i Vertikalplanet mellem Teltpladsen og Poldetind, bliver Azimut af Poldetind for Standard-Kompasset ombord N 48.°1 E. Poldetinds Afstand fra Husø er 10 Kvartmil, saa at en Forrykning lodret paa Sigtelinen mellem begge Steder af 0.°1 svarer til 32.4 Meter, en Afstand, der er meget større end Forrykningen af Kompassets Plads under Svingningen.

Trækkes Azimut af Poldetind — 48.°1 — fra Pejlingen af Poldetind, faar man det sande Azimut af Kompasnaalens Nordende eller den devierende Misvisning. Den følgende Tabel indeholder Observationerne og de deraf beregnede Værdier for devierende Misvisning.

superable obstacles to the use of the Fox circle at sea. The conditions for successful observation with the instrument are a vessel broad in the beam and easy to steer, calm weather and sufficient time, and above all such a position for the instrument as will admit of satisfactory agreement in its determinations of inclination and intensity.

Hence, the only observations attended with trustworthy results, were those taken to find the declination.

Before proceeding to describe the method adopted at sea and give the computed results, I must first set forth the results of the observations taken at Husø for determining the deviation of the compass.

On the 13th of June, 1876, I swung the ship in Husø harbour, by means of hawsers, to obtain the deviation of the compass. For every course by compass (16 different points) on which I observed, the bearing of the Poldetind signal was taken with the compass, Professor Mohn, at a given signal, simultaneously observing the magnetometer in the tent on shore, to determine the absolute declination. As previously stated, page 8, the azimuth of the Poldetind signal from the tent was N. 48° 7.'5 E. Now, as the ship (standard compass on board) lay when swinging very nearly in the vertical plane between the tent and Poldetind, the azimuth of Poldetind for the standard compass on board will be N. 48.°1 E. The distance of Poldetind from Husø is 10 miles; and hence a change in position of 0.°1 perpendicular to the line of vision between both places, corresponds to 32.4 metres, a distance much greater than is that corresponding to the change in the position of the compass during the swinging of the ship.

If the azimuth of Poldetind — 48.°1 — be subtracted from the bearing of Poldetind, we get the true azimuth of the north end of the compass-needle, or the deviating variation. In the following Table are given the observations, and the values computed from them, for deviating variation.

Klokkeslet. (*Hour.*)	Anlagt Kurs paa St. Kompas. (*Ship's Head by Stnd. Compass.*)	Pejling af Poldetind. (*Bearing of Poldetind.*)	Devierende Misvisning. (*Deviating Variation.*)
10^h 34^m a. m.	S 0.°2 E	N 66.°0 E	N 17.°9 W
10 55	S 21.6 E	75.1	27.0
11 58	S 45.0 E	82.3	34.2
0 28 p. m.	S 67.4 E	85.4	37.3
0 49	E	85.0	36.9
1 5	N 67.5 E	82.7	34.6
1 29	N 44.9 E	77.7	29.6
1 32	N 22.5 E	72.5	24.4
1 51	N 0.2 E	67.0	18.9
4 15	N 22.7 W	61.5	13.4
4 32	N 45.3 W	56.3	8.2
4 52	N 67.5 W	51.9	3.8
5 21	N 89.7 W	48.6	0.5
5 40	S 67.2 W	48.3	0.2
5 58	S 45.3 W	50.5	2.4
6 15	S 22.8 W	57.1	9.0
6 45	S 0.7 E	66.0	17.9

Tallene i den sidste Rubrik, den devierende Misvisning, afsattes som Ordinater paa Rudepapir, med Tallene i den anden Rubrik, anlagt Kurs paa Standard-Kompas, som Argument. Paa grafisk Vej droges mellem de afsatte Punkter den sandsynligste Kurve, og af denne Kurve udtoges følgende Værdier: C = Anlagt Kurs efter St. Kompasset. D = Devierende Misvisning

The figures in the last column, the deviating variation, were set down as ordinates on ruled paper, with the figures in the second column as abscissæ. A free hand curve was then drawn as nearly as possible through all the marked points, and from this curve were deduced the following values (C signifies "course by compass;" D, "deviating variation"): —

C	D	C	D	C	D	C	D
N	18.°8 W	E	37.°0 W	S	17.°8 W	W	0.°4 W
N 10° E	21.3	S 80° E	37.4	S 10° W	13.8	N 80° W	1.6
20	23.8	70	37.3	20	10.0	70	3.3
30	26.1	60	36.6	30	6.6	60	5.2
40	28.4	50	35.2	40	3.8	50	7.2
50	30.8	40	33.0	50	1.6	40	9.4
60	33.1	30	30.0	60	0.6	30	11.8
70	35.0	20	26.5	70	0.1	20	14.0
80	36.4	10	22.1	80	0.0	10	16.5

Medium af de devierende Misvisninger i denne Tabel er

18.°68 West.

Ifølge Side 7 var Middel-Misvisningen paa Teltpladsen paa samme Tid 18° 14.′7 = 18°.24.

Paa Skjæret østenfor Havnen fandt Prof. Mohn (Side 11) den 16de Juni Misvisningen om Formiddagen = 19° 0′, om Eftermiddagen 18° 2′, i Middel 18° 31′ = 18°.52. Da Fartøjet under Svingningen laa mellem Teltpladsen og Skjæret, turde det være rigtigst at sætte Misvisningen paa Skibets Plads lig

18.°38 West.

Dette Tal er kun 0.°30 mindre end *Middeltallet af de devierende Misvisninger ombord. Det sidste giver saaledes den sande Misvisning med en Nøjagtighed af mindst en halv Grad.* Efter dette Princip udførtes Misvisningsbestemmelserne i Søen. Til Bedømmelse af Skibets magnetiske Forhold hidsættes de beregnede Værdier for Konstanterne i Deviations-Formelen.

The mean of deviating variation in this Table is

18.°68 W.

As previously shown, page 11, the mean declination simultaneously found at the tent was 18° 14.′7 = 18.°24.

On the islet east of the harbour, Professor Mohn found the declination in the forenoon of the 16th of June = 19° 0′, in the afternoon 18° 2′, giving a mean of 18° 31′ = 18.°52. Now, as the vessel lay when swinging between the tent and the islet, the declination for the ship's position may be put at

18.°38 W.

This value is only 0.°30 less than *the mean of the deviating variations observed on board. Hence, this mean gives the true variation within half a degree.* On this principle was determined the variation at sea. To show the magnetic influence of the vessel, the computed values of the constants in the deviation formula are here given. —

$$A = 0.°0;\ B = \quad 18.°47;\ C = -0.°45;\ D = +2.°47;\ E = +0.°23.$$

Deviationen er 0 for anlagt Kurs Nord og Syd, Maximum, 18.°5, for Ost og West.

Misvisnings-Bestemmelserne i Søen udførtes paa følgende Maade. Skibet blev, i roligt Vejr og under Solskin, ved Maskine og Ror bragt til at ligge an forskjellige, i Regelen 16, Kurser, saa jevnt som muligt fordelte over hele Horizonten. For hver af disse anlagte Kurser bestemtes Vinkelen mellem Diametralplanet og Solens Vertikal-

The deviation is 0 with the ship's head due north or south, its maximum with the ship's head due east or west being 18.°5.

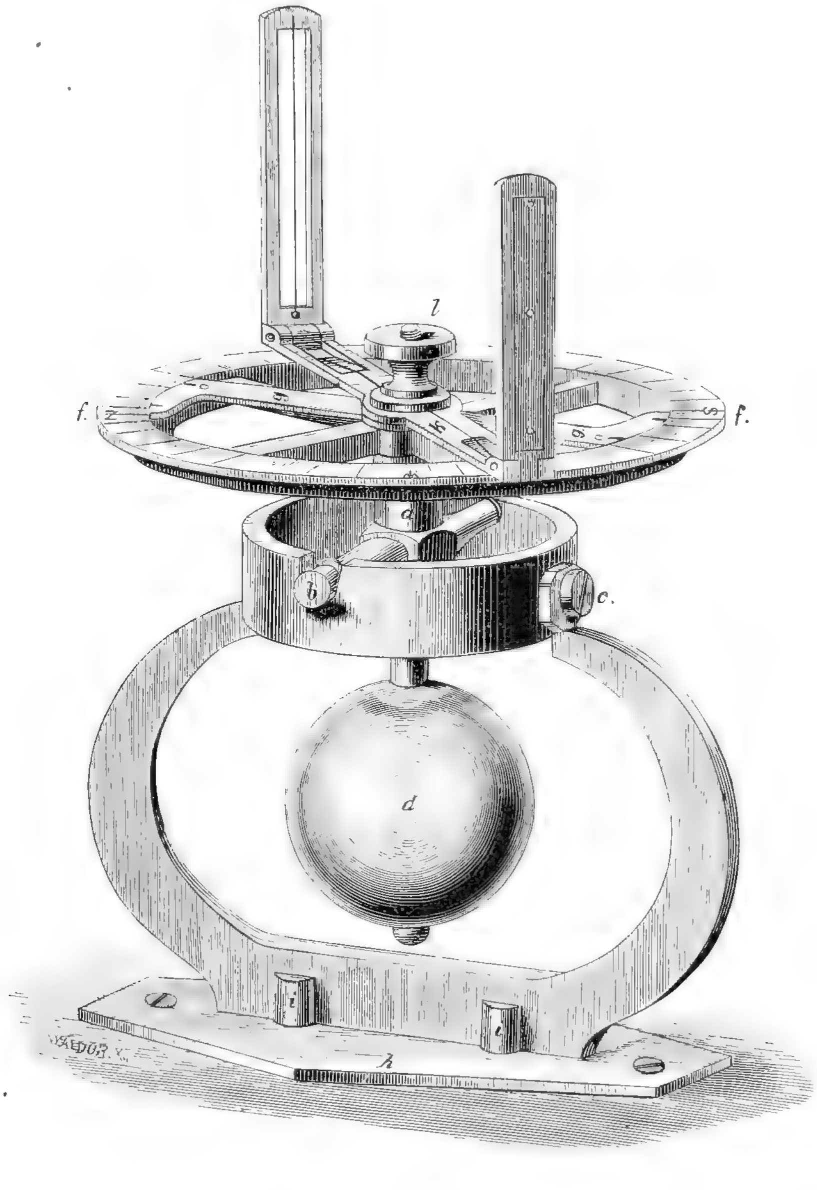
The determinations of declination at sea were performed as follows: — In calm, bright weather the ship's head was brought upon different points of the compass, as a rule 16, as regularly distributed round the circumference as possible. For each of these points was determined the angle between the midship line and the vertical circle of

cirkel. Dette gjordes en enkelt Gang (i 1877) ved Hjælp af Kompassets Pejlapparat, men i Regelen (i 1878) paa nedenfor beskrevne Maade.

Da enhver Pejlings Nøjagtighed væsentligst beror paa, at Kompasnaalen er i Ro og rigtig indstillet i den devierende magnetiske Meridian, og da Naalen let kan bringes i Svingninger ved Manipulationen af Pejlapparatet, naar dette er anbragt direkte paa Kompasdaasen, anvendtes til Pejlinger Wille's Azimuth Pejlskive, et Instrument, som jeg konstruerede i 1869 og som siden har været reglementeret i den norske Marine. Instrumentet er fremstillet i hosstaaende Figur, og vil lettelig forstaaes af Tegningen.

the sun. On one occasion (1877) this was done by means of the sight vanes on the standard compass, but subsequently without exception in the manner described below.

As the accuracy of every bearing is mainly dependent upon the compass-needle being steady, and parallel to the deviating magnetic meridian, and as the needle will be easily caused to vibrate when manipulating the bearing apparatus, if the latter be fixed direct to the compass-box, — all bearings were taken with Wille's Azimuth Dumbcard, an instrument devised by the author in 1869, and which has since been officially adopted for the Norwegian Navy. The instrument is represented in the Figure.



Paa Grund af Bevægeligheden om Tapperne b og c vil Kuglen d, der er af Bly, altid holde Tappen a vertikal, og Ringen f, der med sit Centerstykke kan drejes om den øvre Del af Tappen a, vil saaledes indtage en horizontal Stilling og bibeholde denne under Skibets Bevægelser. Ringen er inddelt i 360° og er tillige mærket med de 8 Hovedstreger N, NO, O, SO o. s. v. Til Overkant af Tappen a er fastskruet Tverstykket g, paa hvilket er an-

The ball d, which is of lead, moving readily on the pivots b and c, will always keep the pivot a perpendicular; and the ring f, which along with its centre-piece can be made to revolve about the upper part of the pivot a, will accordingly take a horizontal position and keep it during the motion of the vessel. The ring is divided into 360 degrees, with separate marks for the 8 cardinal points, N., NE., E., SE., &c. To the upper edge of the pivot a is

mærket to diametralt staaende Nulpunkter (Indexer), og Beslaget h skal være saaledes placeret, at naar Pejlskiven nedsættes i dette med sine to Tapper $i\ i$, saa skal Linjen mellem de to Nulstreger paa det faste Tverstykke g være parallel med Skibets Diametralplan. Om en tyndere Fortsættelse af Tappen a bevæger sig Diopterlinealen k med sine Dioptere, og kan fæstes i en hvilkensomhelst Vinkel med g ved Hjælp af Skruen l.

Pejlingen foregik altsaa saaledes: En Observatør passede Styringen og aflæste nøjagtig anlagt Kurs i Observationsøjeblikket, en anden havde Kronometret og Noticebogen, og en tredie stod ved Pejlskiven. Naar Skibet gik støt, uden Giringer, og Kompasnaalen var i Ro, pejltes Solen enten direkte eller, naar den var højere paa Himlen, ved Hjælp af Skyggen af den vertikale Traad og Diameterstregen paa Linealen k. Naar disse var nøjagtig overet, raabtes "Nu!" og Kronometrets Visende noteredes; derefter opgaves anlagt Kurs, der ligeledes noteredes, og Ringen f drejedes saaledes, at den samme Kursstreg kom overet med Nulpunktet paa g. Inddelingen paa Ringen havde da nøjagtig samme Stilling til Diametralplanet som Inddelingen paa Kompasrosen havde i det Øjeblik, da der blev raabt "Nu", hvorpaa Pejlingen aflæstes paa Ringen i Aabningen og ligeud for Diameterstregen paa Linealen k, som om den var aflæst direkte paa Kompasrosen. Dersom Linealen k under en forlig eller agterlig Pejling dækker Nulstregen, benyttes de to Hjælpestreger, der er anbragte et vist Antal Grader til Siden af den egentlige Nulstreg.

Kronometrets Stand for sand Tid ombord bestemtes enten efter dets Stand for Greenwich Tid og Skibets beregnede Længde eller, naar Dagstiden var gunstig, det er Solen ikke for nær Meridianen, ved at tage nogle Solhøjder og deraf beregne Solens Timevinkel.

Af den saaledes fundne Uhrkorrektion, den efter Kronometret noterede Tid, Bredden og Solens Deklination beregnedes Solens Azimut. Forskjellen mellem Solens sande Azimut og Pejlingen af Solen gav de til de forskjellige anlagte Kurser svarende Værdier for den devierende Misvisning. Efter den ovenbeskrevne grafiske Methode bestemtes derpaa Middeltallet af de ækvidstante Værdier for denne, hvilket antoges som den sande Misvisning.

De følgende Tabeller indeholder Observationerne og de deraf udledede Resultater. t = Klokkeslettet efter sand Soltid, S Pejling af Solen, a Solens Azimut.

screwed a cross-piece, g, marked with two diametrically opposite zero-points (indices), and the frame h must be so placed that, on inserting into it the dumb-card with its two pivots $i\ i$, the line between the two zero-points on the fixed cross-piece g will be parallel to the middle fore and aft line of the ship. On a thinner continuation of the pivot a moves a cross-piece, k, with sight-vanes, which admits of being fixed at any required angle with g by means of the screw l.

The bearings were taken accordingly as follows: — One observer looked to the steering, and read off the exact compass course at the moment of observation, another had charge of the chronometer and noted the time, and a third observed the azimuth dumb-card. Now, when the ship kept steady on her course without yawing, and with the compass-needle at rest, the bearing of the sun was taken either direct or, for greater altitudes, by the shadow of the vertical wire and the diameter-line on the cross-piece k. The moment the shadow of the thread and the line were exactly coincident, observer No. 3 called out to his colleague with the chronometer, who noted and entered the time, after which the direction of the ship's head by the compass was given, and entered in the note-book, the ring f being then moved in such manner that the division corresponding to the direction of the ship's head by compass was made coincident with the zero-point on the cross-piece g. Hence, the division-lines on the ring had precisely the same position relative to the midship line as the division-lines on the compass-card at the moment observer No. 3 called out, and the bearing was then read off through the open space in the centrepiece k, the extremities of the diameter-line being the index, exactly as though it had been read off direct from the compass-card. Should the piece k when taking a bearing in or near the direction of the fore and aft midship line cover the zero-point, recourse is in that case had to the two lines drawn a certain number of degrees from the true zero-point, one on either side.

The error of the chronometer on apparent time on board was found either from its error on Greenwich time and the ship's computed longitude, or, at a favourable hour of the day, i. e. with the sun not too near the meridian, by taking a few solar altitudes and computing the hour-angle of the sun.

From the error of the chronometer thus determined, the observed chronometer-time, the latitude, and the sun's declination, was computed the azimuth of the sun. The difference between the true azimuth and the bearing of the sun gave the values for deviating variation corresponding to the different compass courses. By the diagramatic method described above was found the mean of the equidistant values for the deviating variation, which we assumed to be the true declination.

In the following Tables are set forth the observations and their computed results: t signifies apparent time; S, bearing of sun; a, azimuth of sun.

I. Vestfjorden. *(The West Fjord).* 1877. August 10.

$\varphi = 68^\circ\ 5'$ N. $\lambda = 14^\circ\ 30'$ E. Greenwich.

No.	*C*	*t*	*a*	*S*	*D*
1	SE	$4^h\ 48^m\ 50^s$	N 100° 42′ W	N 71° 40′ W	29.°0 W
2	SE	49 53	100 27	71 20	29.1
3	SSE	57 28	98.6	77 30	21.1
	S	5 2 3	97.5	86 30	11.0
4	S 0° 20′ E	2 47	97.3	86 10	11.1
	S 1° W	4 11	97.1	87 0	10.1
5	SSW	9 44	95.8	S 84 40 W	0.5
	SSW	10 36	95.6	84 30	0.1 W
6	SW	15 29	94.4	79 0	6.9 E
	SW			78 30	
7	WSW	20 34	93.2	76 0	10.6
	WSW			76 20	
8	S 88° W	23 4	92.6	76 40	10.6
	W			77 5	
9	N 69.°5 W	27 19	91.6	81 20	7.1
	N 67 W	27 56	91.4	81 40	6.9
10	NW	31 25	90.7	87 0	2.0 E
	NW			87 30	
11	N 24° W	33 50	90.1	N 85 30 W	4.6 W
	N 21 W	36 33	89.5	84 20	5.2
12	N 1.°5 E	42 51	88.0	76 20	11.8
	N 1.5 E			76 0	
13	NNE	47 45	87.0	68 40	18.2
	NNE			69 0	
14	NE	51 30	86.0	61 30	24.4
	NE			61 40	
15	ENE	55 46	85.0	55 30	29.6
	ENE			55 20	
16	E	58 59	84.3	51 10	33.0 W
	E			51 20	

$A = 0.°0;\ B = -\ 21.°92;\ C = -\ 0.°25;\ D = +\ 2.°50;\ E = +\ 0.°62.$

Ved denne og alle de følgende Bestemmelser var den forreste Jollebom om Bagbord svunget ud; i Husø var den svunget indover.

For this and all subsequent determinations, the foremost port davit was swung *out*, excepting at Husø, where it was swung *in*.

C	*D*	*C*	*D*	*C*	*D*	*C*	*D*
N	11.°6 W	E	33.°1 W	S	10.°5 W	W	10.°5 E
N 10° E	14.7	S 80° E	33.6	S 10° W	5.8	N 80° W	9.3
20	17.6	70	33.4	20	1.3 W	70	7.6
30	20.5	60	32.4	30	2.6 E	60	5.4
40	23.1	50	30.3	40	5.7	50	2.9
50	25.7	40	27.5	50	8.3	40	0.2 E
60	28.2	30	24.0	60	10.0	30	2.5 W
70	30.3	20	20.0	70	11.0	20	5.4
80	32.0	10	15.4	80	11.1	10	8.3

Middel af *D* = Misvisning = 11.°2 W. Mean of *D* = variation = 11.°2 W.

2. Bergen. Byfjorden. (*Bergen. The Byfjord.*) 1878. Juni 14.

$\varphi = 60° \ 23.'9$ N. $\lambda = 5° \ 54.'0$ E. Greenwich.

No.	C	t	a	S	D
1	N 20.°5 E	$5^h \ 25^m \ 47^s$	N 85.°2 W	N 61.°0 W	24.°2 W
2	S 79. W	37 49	82.7	82.0	0.7
3	S 58. W	41 10	82.0	80.5	2.5
4	S 37. W	44 0	81.4	75.5	5.9
5	S 17.5 W	47 11	80.7	69.0	11.7
6	S 1.2 W	49 13	80.3	62.7	17.6
7	S 8. E	51 20	79.8	53.7	26.1
8	S 68.5 E	54 52	79.1	42.5	36.6
9	N 88. E	57 20	78.6	43.0	35.6
10	N 58. E	6 0 17	77.9	47.3	30.6
11	N 35.7 E	2 16	77.5	52.0	25.5
12	N 9.7 E	4 29	77.1	56.7	20.4
13	N 3. W	6 18	76.7	59.8	16.9
14	N 36.5 W	9 53	75.9	67.0	8.9
15	N 68.7 W	13 42	75.2	74.0	1.2
16	N 89.5 W	17 8	74.5	72.8	1.7
17	N 69.5 W	19 52	73.9	70.5	3.4
18	N 55.2 W	22 19	73.4	67.2	6.2
19	N 48. W	25 26	72.8	64.8	8.0
20	N 20.5 W	28 14	72.2	59.0	13.2
21	N 11. W	30 21	71.7	57.0	14.7

$A = + 0.°0$; $B = - 17.°48$; $C = + 0.50$; $D = - 2.°33$; $E = + 0.°24$.

C	D	C	D	C	D	C	D
N	17.°6 W	E	36.°0 W	S	18.°2 W	W	1.°0 W
N 10° E	20.1	S 80° E	36.7	S 10 W	14.5	N 80° W	2.0
20	22.5	70	36.7	20	10.9	70	3.3
30	24.7	60	36.0	30	7.7	60	4.8
40	26.9	50	34.7	40	5.0	50	6.6
50	29.0	40	32.4	50	3.0	40	8.6
60	31.1	30	29.4	60	1.7	30	10.7
70	33.0	20	25.8	70	0.8	20	13.0
80	34.6	10	22.0	80	0.6	10	15.2

Middel af D = Misvisning = 18.°2 W. Mean of D = Variation = 18.°2 W.

3. **Øst-Finmarken.** *(East Finmark.)* **1878. Juni** *(June)* **25.**

$\varphi = 70°.45'.8$ N. $\lambda = 30°$ 6.'6 E. Greenwich

No.	C	t	a	S	D
1	S 45.°5 E	6^h 20^m 41^s	N 77.°0 W	N 58.°6 W	18.°4 W
2	S 63.75 E	23 12	76.5	54.8	21.7
3	S 78.5 E	24 37	76.2	54.2	22.0
4	N 88.5 E	27 7	75.6	54.0	21.6
5	N 74.5 E	28 54	75.2	55.2	20.0
6	N 59. E	30 42	74.8	57.9	16.9
7	N 43.25 E	32 47	74.4	62.0	12.4
8	N 25.6 E	34 23	74.0	66.8	7.2
9	N 9.3 E	37 47	73.2	71.3	1.9 W
10	N 2.3 E	39 45	72.8	73.6	0.8 E
11	N 11. W	41 13	72.4	78.2	5.8
12	N 23.6 W	42 58	72.0	80.0	8.0
13	N 40.3 W	44 19	71.7	84.8	13.1
14	N 54.6 W	46 19	71.2	N 87.2 W	16.0
15	N 69. W	48 18	70.8	S 89.2 W	20.0
16	N 83.3 W	49 44	70.5	87.9	21.6
17	S 80. W	52 21	69.9	87.9	22.2
18	S 65.3 W	53 58	69.5	S 89.2 W	21.3
19	S 52.6 W	56 15	69.0	N 89.1 W	20.1
20	S 40.3 W	58 6	68.6	86.1	17.5
21	S 30.3 W	7 0 20	68.1	82.2	14.1
22	S 16.6 W	2 37	67.6	75.2	7.6
23	S 1.5 W	4 30	67.2	67.2	0.0
24	S 10.3 E	6 6	66.8	62.3	4.5 W
25	S 19. E	8 9	66.3	57.3	9.0
26	S 26.5 E	11 18	65.6	54.0	11.6
27	S 34.5 E	13 0	65.2	49.5	15.7 W

$A = +\ 0.°05;\ B = -\ 22.°22;\ C = +\ 0.°43;\ D = +\ 2.°30;\ E = +\ 0.°22.$

C	D	C	D	C	D	C	D
N	1.°2 E	E	21.°9 W	S	0.°1 W	W	22.°1 E
N 10 E	2.2 W	S 80 E	22.4	S 10 W	4.5 E	N 80 W	21.2
20	5.4	70	22.2	20	9.3	70	19.7
30	8.6	60	21.3	30	13.6	60	17.7
40	11.6	50	19.5	40	16.8	50	15.3
50	14.5	40	16.8	50	19.4	40	12.6
60	17.1	30	13.5	60	21.0	30	9.9
70	19.3	20	9.5	70	22.0	20	7.1
80	21.0	10	5.0	80	22.3	10	4.3

Middel af D = Misvisning = 0.°2 E. Mean of D = Variation = 0.°2 E.

4. Vest-Finmarken (*West Finmark*). 1878, Juli (*July*) 13.

$\varphi = 71^\circ\ 7'$ N. $\lambda = 21^\circ\ 11'$ E. Greenwich.

No.	C	t	a	S	D
1	N 89.° W	$5^h\ 2^m\ 26^s$	N 96.″2 W	N 112.″2 W	16.′0 E
2	N 71 W	4 49	95.6	108.8	13.2
3	N 43 W	7 52	94.9	100.8	5.9
4	N 24 W	9 21	94.6	96.5	1.9 E
5	N 2 E	11 56	93.9	90.1	3.8 W
6	N 22.5 E	14 39	93.3	82.4	10.0
7	N 45.5 E	16 35	92.8	74.0	18.8
8	N 65 E	20 5	92.0	67.4	24.0
9	E	22 8	91.5	64.0	27.5
10	S 67.5 E	25 51	90.6	63.5	27.1
11	S 45 E	28 9	90.1	66.1	24.0
12	S 23 E	31 34	89.2	72.4	16.8
13	S	33 55	88.7	82.0	6.7
14	S 0.5 W	35 15	88.3	82.0	6.3 W
15	S 22.5 W	37 44	87.7	93.0	5.3 E
16	S 43.5 W	39 20	87.4	101.0	13.6
17	S 67 W	41 46	86.9	103.0	16.1
18	N 89 W	45 55	85.9	102.0	16.1 E

$A = 0.'0$; $B = 22.17$; $C = -0.''22$; $D = + 2.''78$; $E = + 0.''05$.

C	D	C	D	C	D	C	D
N	5.″0 W	E	27.″6 W	S	6.″5 W	W	16.″3 E
N 10 E	8.0	S 80 E	28.0	S 10 W	1.3 W	N 80 W	14.9
20	11.0	70	27.8	20	3.6 E	70	13.0
30	14.1	60	26.7	30	8.2	60	11.2
40	17.2	50	25.0	40	11.8	50	8.5
50	20.2	40	22.5	50	14.4	40	6.0
60	22.9	30	19.4	60	16.3	30	3.5
70	25.1	20	15.6	70	17.0	20	0.7 E
80	26.7	10	11.3	80	16.9	10	2.1 W

Middel af D = Misvisning = 5.′6 W. Mean of D = Variation = 5.′6 W.

5. **Det norske Hav.** *(The Norwegian Sea.)* 1878. Juli *(July)* 20.

$\varphi = 75° 3' N.$ $\lambda = 5° 13' E.$ Greenwich.

No.	C	t	a	S	D
1	S 45.°5 E	4ʰ 19ᵐ 19ˢ	N 109.°1 W	N 66.°7 W	42.°4 W
2	S 69.3 E	21 31	108.6	61.0	47.6
3	S 89 E	23 55	108.0	61.5	46.5
4	N 68.3 E	26 13	107.3	64.2	43.1
5	N 42.6 E	29 47	106.4	69.7	36.7
6	N 18 E	32 15	105.8	80.2	25.6
7	N	34 2	105.4	85.2	20.2
8	N 27 W	40 5	104.0	94.8	9.2
9	N 46.3 W	41 47	103.6	99.7	3.8 W
10	N 65 W	43 22	103.1	103.2	0.1 E
11	N 89.3 W	44 55	102.7	107.3	4.6
12	S 68 W	46 50	102.2	107.2	5.0 E

$A = + 0.°02; \; B = - 26.°42; \; C = 0.°0; \; D = + 2.87; \; E = + 0.°48.$

C	D	C	D	C	D	C	D
N	20.°2 W	E	46.9 W	S	20.°0 W	W	4.°8 E
N 10° E	24.1	S 80° E	47.3	S 10 W	13.8	N 80° W	3.8
20	28.0	70	47.0	20	8.2	70	0.2 E
30	31.5	60	45.9	30	3.6	60	2.0 W
40	35.0	50	43.9	40	0.0	50	2.9
50	38.2	40	40.8	50	2.6 E	40	5.6
60	41.0	30	36.9	60	4.4	30	8.9
70	43.5	20	32.0	70	5.3	20	12.5
80	45.5	10	26.3	80	5.3	10	16.1

Middel af D = Misvisning = 20.°5 W. Mean of D = Variation = 20.°5 W.

6. Sydkap, Spidsbergen. *(South Cape, Spitzbergen.)* **1878. August** *(August)* **5.**

$\varphi = 76° 27'$ N. $\lambda = 17° 0'$ til $17° 10'$ E. Greenwich.

No.	*C*	*t*	*a*	*S*	*D*
1	N 89.°3 E	7^h 48^m 47^s	N 59.°9 W	N 20.°0 W	39.°9 W
2	N 68.3 E	51 47	59.2	23.1	36.1
3	N 45.6 E	58 23	57.6	29.7	27.9
4	N 18.3 E	8 0 52	57.1	39.9	17.2
5	N 23 E	2 58	56.6	37.3	19.3
6	N 2.3 W	6 7	55.8	49.2	6.6
7	N 2 E	9 41 45	33.1	23.8	9.3
8	N 24.3 W	44 8	32.5	31.5	1.0 W
9	N 50.3 W	46 19	32.0	40.5	8.5 E
10	N 70 W	48 25	31.5	44.2	12.7
11	N 88.6 W	51 22	30.8	45.1	14.3
12	S 88.3 W	56 21	29.6	45.3	15.7
13	S 65 W	10 0 13	28.7	43.8	15.1
14	S 43.6 W	3 32	27.9	37.2	9.3
15	S 24.3 W	7 8	27.0	28.2	1.2 E
16	S 0.3 W	9 57	26.4	15.2	11.2 W
17	S 22.6 E	13 11	25.6	N 1.9 W	23.7
18	S 47.3 E	15 48	24.9	N 9.7 E	34.6
19	S 71.6 E	20 38	23.8	15.1	38.9
20	N 85.3 E	25 34	22.6	N 16.2 E	38.8

$A = + 0.°02$; $B = - 27.°67$; $C = + 0.°62$; $D = + 2.°47$; $E = + 0.°49$.

C	*D*	*C*	*D*	*C*	*D*	*C*	*D*
N	10.°5 W	E	39.°7 W	S	11.°5 W	W	16.°0 E
N 10 E	14.4	S 80 E	40.2	S 10 W	5.8	N 80 W	14.8
20	18.3	70	39.7	20	0.7 W	70	13.1
30	22.0	60	38.1	30	4.0 E	60	10.5
40	25.7	50	35.5	40	8.0	50	7.6
50	29.5	40	31.9	50	11.4	40	4.4
60	33.1	30	27.5	60	14.0	30	1.0 E
70	36.2	20	22.5	70	15.7	20	2.5 W
80	38.3	10	17.0	80	16.3	10	6.3 W

Middel af D = Misvisning = 11.°4 W. Mean of D = Variation = 11.°4 W.

7. **Grønlandshavet.** *(The Greenland Sea.)* **1878. August 9.**

$\varphi = 76^\circ\ 27'$ N. $\lambda = 0^\circ\ 56'$ W. Greenwich.

No.	C	t (a. m.)	a	S	D
1	S 56.°3 E	$10^h\ 41^m\ 53^s$	S 21.°5 E	S 32.°0 W	53.°5 W
2	S 35 E	45 30	20.5	24.9	45.4
3	S 17.3 E	48 40	19.6	15.8	35.4
4	S 2 W	51 6	19.0	S 6.3 W	25.3
5	S 23.3 W	53 14	18.4	S 3.2 E	15.2
6	S 50 W	55 46	17.7	14.4	3.3 W
7	S 64.3 W	57 16	17.3	18.5	1.2 E
8	N 89 W	59 11	16.8	20.6	3.8 E
9	N 71 W	11 2 14	15.9	15.4	0.5 W
10	N 51.3 W	8 40	14.2	S 7.7 E	6.5
11	N 17.6 W	10 39	13.6	S 6.2 W	19.8
12	N 2 E	13 13	12.9	14.9	27.8
13	N 15 E	19 16	11.2	21.0	32.2
14	N 51.3 E	22 6	10 5	35.0	45.5
15	N 64.6 E	26 0	9.4	39.0	48.4
16	N 87 E	28 6	8.8	44.5	53.3
17	S 72.3 E	30 1	8.3	45.8	54.1
18	S 48.6 E	32 16	7.6	41.4	49.0
19	S 68.6 E	37 26	6.2	S 46.8 W	53.0 W

$A = -0.°32$; $B = -28.°17$; $C = -0°33$; $D = +2.°30$; $E = -0.°80$.

C	D	C	D	C	D	C	D
N	26.°7 W	E	53.°7 W	S	26.°7 W	W	3.°6 E
N 10° E	30.5	S 80.° E	54.3	S 10° W	21.5	N 80° W	2.0 E
20	34.3	70	54.0	20	16.5	70	0.5 W
30	38.0	60	52.7	30	11.7	60	3.5
40	41.5	50	50.2	40	7.3	50	6.8
50	44.8	40	46.6	50	3.3 W	40	10.6
60	47.8	30	42.3	60	0.2 E	30	14.7
70	50.4	20	37.3	70	2.6	20	18.7
80	52.4	10	32.0	80	3.8 E	10	22.7 W

Middel af D = Misvisning = 25.°9 W. Mean of D = Variation = 25.°9 W.

Oversigts-Tabel. *(Synoptic Table.)*

Station.	Nordl. Bredde (*North Latitude*)	Længde fra Gr. (*Longitude*)	Datum (*Date*)	Klokkeslet (*Hour*)	Declination	Horizontal-Intensitet (*Horizontal Intensity*) Brit. Un.	Metr. Un.	m	Inclin. θ
Bergen	60° 23.′9	5° 24.′0 E	1876 Mai 22	1—2 p. m.		3.2238	1.4864	0.7666	
—				3—4½ p. m.					72° 24.′3
Huso	60 59.6	4 37.0 E	1876 Juni 10	4—6 p. m.	18° 19′ W	3.1732	1.4631	0.7653	
—			— „ 12	10½—12 a. m.					72 43.4
—			— „ „	1½—2 p. m.					72 41.0
—			— „ „	6 7½ p. m.					72 43.9
—			— „ 13	10½ a.m.—7 p.m.	18 15 W				
—			— „ „	11—12 a. m.					72 46.0
—			— „ 15	12¼—1¾ p. m.		3.1751	1.4640	0.7650	
—			— „ „	2¼ p. m.		3.1750	1.4640		
—			— „ „	6¼ p. m.		3.1746	1.4637		
—			— „ „	7¼ p. m.					72 45.5
Do. Skjær (*Islet*)			— „ 16	11¼ a. m.	19 0 W				
— —			— „ „	12—1 p. m.		3.1686		0.7666	
— —			— „ „	2¼ p. m.		3.1734	1.4632		
— —			— „ „	6½ p. m.					72 44.8
— —			— „ „	7½ p. m.	18 2 W				
Husø			1877 Mai 23	5½ p. m.					72 43.4
—			— Juni 4	4—5 p. m.		3.1761	1.4644	0.7442	
Reykjavik	64 8.5	21 54.1 W	1876 Juli 28	5—6½ p. m.					76 28.5
—			— „ 29	5½ p. m.	38 19 W				
—			— „ 31	10—12¼ p. m.		2.6141	1.2053	0.7615	
—			— „ „	4—6 p. m.		2.6407	1.2176	0.7612	
—			— Aug. 1	1¼—2¼ p. m.					76 26.3
Namsos	64 28.2	11 31.5 E	1876 Aug. 18	11½—2 p. m.		2.9639	1.3666	0.7576	
—			— „ „	6 p. m.	13 43 W				
—			— „ 19	10½—11½ a. m.					74 2.3
—			— „ „	5—6 p. m.					74 2.3
Kristiania	59 54.7	10 43.6 E	1876 Oct. 2	11 a. —2 p. m.		3.4664	1.5983	0.7547	71 4.7
Bodø	67 17.2	14 24.9 E	1877 Aug. 13	9¾—11¼ a. m.					75 21.4
—			— „ „	12¼—5½ p. m.		2.7854	1.2842	0.7402	
—			— „ „	6 p. m.	11 41 W				
Tromsø	69 39.1	18 59.3 E	1877 Juli 11	11¾—12¾					76 21.9
—			— „ „	4—6¼ p. m.		2.6365	1.2155	0.7426	
—			— „ „	7 p. m.	10 18 W				
Hammerfest	70 40.2	23 40.4 E	1877 Juli 9	5¾—24 p. m.		2.5484	1.1750	0.7627	
—			— „ 10	10¾—12 a. m.					76 54.3
—			— „ „	12½ p. m.	5 29 W				
Vardø	70 22.4	31 7.8	1878 Juni 26	10¾—11½ a. m.					76 52.4
—			— „ „	1—6 p. m.		2.5737	1.1867	0.7616	
Bergen (*Bergen*)	60 23.8	5 17.1 E	1878 Juni 14	6 p. m.	18.°2 W				
Vestfjorden (*West Fjord*)	68 5	14 30 E	1877 Aug. 10	5½ p. m.	11.2 W				
Vest-Finmarken (*West Finmark*)	71 7	21 11 E	1878 Juli 13	5½ p. m.	5.6 W				
Øst-Finmarken (*East Finmark*)	70 45.8	30 6.6 E	— Juni 25	7 p. m.	0.2 E				
Norske Hav (*Norwegian Sea*)	75 3	5 13 E	— Juli 20	4½ p. m.	20.5 W				
Sydkap Spidsbergen (*South Cape Spitzbergen*)	76 27	17 5 E	— Aug. 5	10 p. m.	11.4 W				
Grønlandshavet (*Greenland Sea*)	76 27	0 56 W	— „ 9	11 a. m.	25.9 W				

H. Mohn. Nogle Bidrag til de nordlige Landes Geografi og Naturhistorie,

sammenstillede efter Iagttagelser, gjorte paa den norske Nordhavs-Expedition 1876—78.

Med 6 farvetrykte Billeder og 9 Træsnit samt 2 Karter.

Ved Nordhavs-Expeditionens Ophold i Havn eller under Kysten af de af det nordlige Atlanterhav og Ishavet beskyllede Lande og Øer, søgte man, saavidt Lejligheden tillod det, at anstille forskjellige Slags Iagttagelser paa Land. Disse Iagttagelser og deres Resultater har jeg, forsaavidt de antages at indeholde nye Oplysninger af Interesse, sammenstillet i de følgende Blade. De medfølgende Billeder, der samtlige ere udførte efter Originaltegninger, tagne paa Stedet, ville i mange Henseender give en langt fuldstændigere Forestilling om Gjenstandene end den vidtløftigste Beskrivelse.

I. Vestmanna-Øerne.

Fra Reden udenfor Havnen, hvor "Vöringen" laa fra den 22de til den 26de Juli 1876, ser man mod Nord Heima-Øens højeste Fjeld, *Heimaklettur*, og mod Nordost Forbjerget *Ystiklettur*. Det er dette sidste, vi se paa Billedet, til hvilket Maleren, Hr. Schiertz, har benyttet sin fortrinlige, paa Stedet tagne Farve-Skitse. De vulkanske Bergarters Forvitringsformer i dette fugtige Klima illustreres udmerket vel paa dette Billede. *Ystiklетturs* stejle Vægge med sine smale Afsatser gjør det til et Fugleberg, hvor den hvide fra Fuglene hidrørende Farve smukt vexler med den naturlige brune, og oventil ser man paa mindre og større Partier den for Nordvest-Europas Ølande ejendommelige saftige grønne Farve af Græsset. Ved Klettens

H. Mohn. Contributions to the Geography and Natural History of the Northern Regions of Europe,

derived from observations made on the Norwegian North-Atlantic Expedition (1876—1878).

With 6 Chromo-lithographs, 9 Wood Engravings, and 2 Maps.

The time passed by the Norwegian Expedition on the coast of such continental tracts and islands as border upon the North-Atlantic and the Arctic Ocean, was devoted, circumstances permitting, to the prosecution of exploratory work on shore. Those of the observations, and their results, that are fraught, it is presumed, with new and interesting data, have been set forth in the following pages. The accompanying illustrations, all of which are from sketches taken on the spot, will convey, in many respects, a much livelier impression of the natural objects they represent than any mere verbal description, however graphic and precise.

I. The Vestmanna Islands.

From the roadstead, without the harbour, where the "Vøringen" lay at anchor from the 22nd to the 26th of July 1876, is seen, looking north, Heima Island's loftiest summit, *Heimaklettur*, and north-east, Cape *Ystiklettur*. It is the latter we have depicted in the plate, for the original of which Mr. Schiertz, artist to the Expedition, made good use of his admirable water-colour sketches, taken on the spot. The rugged forms assumed in this humid climate by the disintegrated volcanic rocks are faithfully rendered. *Ystiklettur*, with its precipitous walls and long, narrow ledges, exhibits the salient features of a fowling-cliff, where the white colour characteristic of bird-haunts is picturesquely blent with the natural brown of the rock; and here and

Fod sees en Hule i Havbrynet; den benævnes *Klettshellir*, og er et af de mange Vidnesbyrd om Havets Virkninger paa Kysterne, paa hvilke Færøernes og Islands Klippestrande ere saa rige. Taagen ligger over Havet og stenger Udsigten til Island selv, med de store Jøkler.

Vende vi fra Ankerpladsen Blikket rundt, saa se vi mod Syd eller Sydvest den lille, men regelmæssige, nu udslukte Vulkan *Helgafell*. Den 23de Juli 1876 gjorde jeg, i Følge med Distriktslægen, Thorsteinn Jonsson, en Tur til Toppen af Helgafell. Vejen gik først over en udstrakt Lava-Mark, *"hraun"*, der skraaner nedad fra Vulkanens Kegle. I denne Lava findes flere Huler. En af dem er sine 20 Meter lang og 10 Meter bred; ovenfra kommer man ned i den gjennem et lidet Hul, gjennem hvilket man kan hoppe ned paa Bunden. I en Højde af omtrent 124 Meter over Havet ophørte Lavamarken og afløstes af den øverste Vulkan- eller Aske-Kegle. Denne bestaar af udkastede løse Masser, tildels af større Dimensioner, som Lavablokke af indtil 1 Meters Længde, men hovedsagelig af mindre, aflangt runde, rødlige Slaggestene og endnu mindre, mørke Smaasten og Sand.

Paa Toppen af Helgafell er der en kraterformet Fordybning. Den største Højde af Krater-Randen ligger mod Sydost, den laveste mod Nordvest. Forskjel i Højde c. 12 Meter. Kraterets Bund ligger igjen omtrent 12 Meter lavere end Randens laveste Parti. Keglens ydre Skraaning har en Heldning af c. 35°. Den er kortest paa Sydsiden, hvor de løse Materialier ikke række saa langt ned som paa Nordsiden, og fra hvilken Side derfor ogsaa Bestigningen er lettest.

Højden af det Punkt, hvor Keglen rækker længst ned paa Nordsiden og hvor Lavamarken begynder, samt Højden af den højeste Kam paa Helgafells Krater er beregnet efter Observationer med Aneroidbarometer. Dette sammenlignedes med Observationerne ombord (der udførtes hver Time), idet jeg aflæste det ved Havfladen før og efter Opstigningen. Desuden anbragtes de ved Undersøgelsen paa det meteorologiske Institut bestemte Correctioner for forskjellige Højder. Luftens Temperatur maaltes med Slyngethermometer. Ved Stranden var den 0.°2 til 0.°3 højere end ombord i "Vøringen". De til Normalbarometer og Normalthermometer reducerede observerede Værdier vare:

there at the summit the eye rests refreshed upon grassy patches of the rich bright-green tint peculiar to the island herbage of north-western Europe. At the foot of the cliff we see a cave, called *Klettshellir*; it is one of the striking proofs given by the sea of its action on coasts, of which so many are to be met with along the rocky shores of the Færoes and Iceland. A mist lies over the ocean, shutting out from view the main land of Iceland, with its great glaciers.

Bearing south, or rather south-west, from the anchorage, we have the small, but in form regular, and now extinct volcano *Helgafell*. On the 23rd of June, 1876, I made an excursion to the top of this mountain, in company with the surgeon of the district, Mr. Thorsteinn Jonsson. The way led at first over a broad expanse of lava, *hraun*, shelving down from the cone of the volcano. In the lava are a number of caves. To one of these, measuring 60 feet in length by 30 in width, access is gained from above through a narrow opening, down which you can leap to the bottom. The field of lava reaches about 370 feet above the sea, as far as the upper cone of the volcano. This cone consists partly of loose ejected masses, for instance blocks of lava measuring as much as 3 feet in length, but chiefly of reddish oval-shaped cinders, along with dark-coloured pebbles and sand.

At the summit of Mount Helgafell there is a crater-like excavation. The height of the edge is greatest towards the south-east, least towards the north-west, the difference being about 40 feet. The bottom of the excavation lies about 40 feet beneath the lowest part of the edge. The outer slope of the cone inclines at an angle of circa 35°. It is shortest on the south-side, where the loose debris do not extend so far down as on the north, and up the southern acclivity the ascent of the mountain is therefore easiest.

The altitude of the lowest point to which the wall of the cone descends on the north side, viz. where the field of lava begins, as also of the loftiest ridge of the crater, was computed from observations with the aneroid barometer. The readings of the instrument at the level of the sea, which I noted before and after the ascent, were compared with the observations on board, taken every hour, and the corrections found at the Meteorological Institute for different altitudes duly applied. The temperature of the atmosphere was taken with the sling thermometer. Along the shore it was from 0.°2 to 0.°3 higher than on board the "Vøringen." The observed values reduced to those of the standard barometer and standard thermometer, were as follows: —

1.	Foden af Keglen *(Foot of Cone)*	Kl. $7^h\ 6^m$ p. m.	Bar. reduc. 736.^{mm}7	Temp. 8.°5 C.
	Havfladen *(Sea-level)*	„ „ —	— — 747. 9	— 9. 5
	Resultat. Højde *(Result. Height)* — 124 Meter *(Metres)*.			
2.	Toppen af Helgafell *(Summit of Helgafell)*	Kl. $7^h\ 22^m$ p. m.	— — 726. 35	— 6. 7
	Havfladen *(Sea-level)*	„ „ —	— — 747. 9	— 9. 4
	Resultat. Højde *(Result. Height)* = 240.5 Meter *(Metres)*.			

2. Jan Mayen.

Den 27de Juli 1877, om Aftenen, kom vi, paa Vejen fra Tromso til Jan Mayen, ind i Polarstrommen. Temperaturen i Havets Overflade, der hele Dagen tidligere havde været 8° og derover, gik hurtig ned til mellem 4° og 5° og en Temperatur af 0° fandtes allerede i 17 Favnes Dyb. Dette var 15 geografiske Mil ost for Jan Mayen. Den følgende Nat og Formiddag dampede vi, under jevnlig Lodning, videre vestover og fandt Dybder paa 829, 968, 796, 1060 og, Kl. 1 Eftm. den 28de, 654 Favne. Endnu viste Jan Mayen sig ikke. Med det kolde Vand havde Polarhavets Taage indfundet sig og taget bort saavel Solen som al Udsigt til Land. Imidlertid tydede, foruden Dybdens Aftagen, den stadig tiltagende Mængde af Sofugl, navnlig Lunder, som saaes flyvende ostover, paa at Landet ikke kunde være langt borte. Med Kursen fremdeles ret mod Vest dampedes fra Pladsen for det sidste Lodskud videre Kl. 1.40 Min. Kl. 2 hortes pludselig forste Styrmands Raab "Jeg ser Isbræen forud". Farten standsedes. Loddet kastedes og viste en Dybde af 144 Favne. I Horizonten, under den lavt liggende Taage, skimtedes en vældig nedoverhængende Isbræ mod den morke Fjeldvæg. Det var Østsiden af Jan Mayen. Med Loddet i Bund bleve vi liggende paa samme Plads et Par Timers Tid. Taagen lettede noget, og vi kunde se nordover til Ostkap og sydover til Sydostkap. Vi laa ligeudenfor den sydligste af Østsidens fem store Isbræer (Petersens Bræ). Afstanden fra Land bestemtes, ved Ekkoet af et Kanonskud, (10.'4 Mellemtid) til en liden Kvartmil (1750 Meter).

Da Sogangen kom fra Nordnordost og der saaes Brændinger paa Stranden, besluttedes det at soge en Ankerplads paa den anden Side af Øen. Vi tog da Loddet ind og dampede nordover. Vejret holdt sig fremdeles taaget, og i det Øjeblik, vi vare naaede til tvers af Nordostkap, lagde Taagen sig saa tæt over Havet, at Landet og Horizonten blev taget ganske bort. Kursen sattes en Stund senere mod Vest, derpaa mod Syd og endelig mod Sydost. Taagen holdt sig hele Tiden over Havet og hindrede al Udsigt. Med korte Tidsmellemrum observeredes Havoverfladens Temperatur som et muligt Varsel om Is i Nærheden. Vi fandt jevnlig over 3°, og ikke lavere end 2.°3. Da vi Kl. 7 om Aftenen efter Bestikket nærmede os Mary Muss Bugten, begyndte vi at lodde, og fortsatte hermed under Farten ind mod det usynlige Land, for paa denne Maade at finde en Ankerplads, til Kl. 10. Kl. $10^1/_2$ begyndte imidlertid heldigvis Taagen at løfte sig, saaat de nedre Dele af Landet bleve synlige. Vi kunde nu orientere os og vælge vor Ankerplads, og Kl. 11 faldt Vøringens Anker i Mary Muss Bugten paa 20 Favne Vand, en god halv Kvartmil fra Stranden.

2. Jan Mayen.

In the evening of the 27th of July, 1877, on our passage from Tromsø to Jan Mayen, we entered the Polar current. The temperature at the surface of the sea, which throughout the day had not been lower than 8°, sank rapidly to between 4° and 5°, and 0° was registered at a depth of 17 fathoms, the position of the ship being then 60 miles east of Jan Mayen. During the night and the forenoon of the following day we steamed on westward, sounding repeatedly, and found the depth to be successively 829, 968, 796, 1060, and, at 1 p. m. on the 28th, 654 fathoms. Still, nothing was to be seen of Jan Mayen. With the frigid water had come the Arctic fog, shrouding both the sun and the land. Meanwhile, divers species of sea-birds, more especially puffins, seen flying eastward in steadily increasing numbers, could not fail to announce, apart from the observed decrease in depth, our comparative proximity to the island Steering due west as before, we steamed on from where the last sounding had been taken (1.40 p. m.), and at 2 p. m. we suddenly heard the first mate shout "Glacier ahead!" The ship's way was immediately deadened, and on heaving the lead, the depth was found to be 144 fathoms. On the horizon, under the low-lying fog, could be descried against the dark mountain-wall a huge, beetling glacier. It was the eastern shore of Jan Mayen. With the lead at the bottom, we remained in the same spot for a couple of hours, when the fog began to clear a little, and looking northward, we could sight Cape East, southward, Cape South-East. The vessel lay right off the most southerly of the 5 large glaciers (Petersen's glacier) on the east coast of Jan Mayen. The distance from land was determined by the echo of a cannon-shot (interval 10.'4), and found to be something under a mile (5742 feet).

The swell coming from the north-north-east, and observing the sea breaking on the shore, we determined to seek a sheltered anchorage on the other side of the island. The lead was accordingly hoisted in, and we steamed northward. The weather still continued thick; and just as the vessel had got abreast of Cape North-East, the fog became all at once so dense that nothing could be seen of the land and the horizon. Shortly after, the course was set west, then south, and finally south-east. Meanwhile, there was no break in the fog, which still hung over the sea, excluding the prospect on every side. At brief intervals we noted the temperature of the surface-water, as a possible indication of the proximity of ice. This was generally found to be 3°, and in no case under 2.°3. At 7 p. m., as, according to our reckoning, we were approaching Mary Muss Bay, we heaved the lead, and continued sounding till 10 o'clock, as we bore down on the fog-shrouded coast to find anchorage for the ship. Fortunately, however, at half-past ten the dense mist began to rise, disclosing the lower parts of the land. We could now look about us and choose our anchorage; and at 11 o'clock the "Vøringen" dropped her anchor in Mary Muss Bay, in 20 fathoms of water, a little more than half a mile from the shore.

Den følgende Morgen var Havet aldeles roligt. Taagen laa fremdeles over Landet, saaat kun de lavere Dele vare synlige, til en Højde af 150 til 200 Meter. Foran os laa det maleriske Fugleberg (Fig. 1), hvis bratte, mørke Vægge mindede om Ystiklettur paa Vestmannaøerne. Ved

The next morning the sea was quite calm, but a thick fog, at the height of 500—600 feet, still hung over the island, only the lower range of coast being accordingly visible. In front towered the "Fugleberg," or fowling-cliff (Fig. 1), which with its dark, precipitous rocks vividly

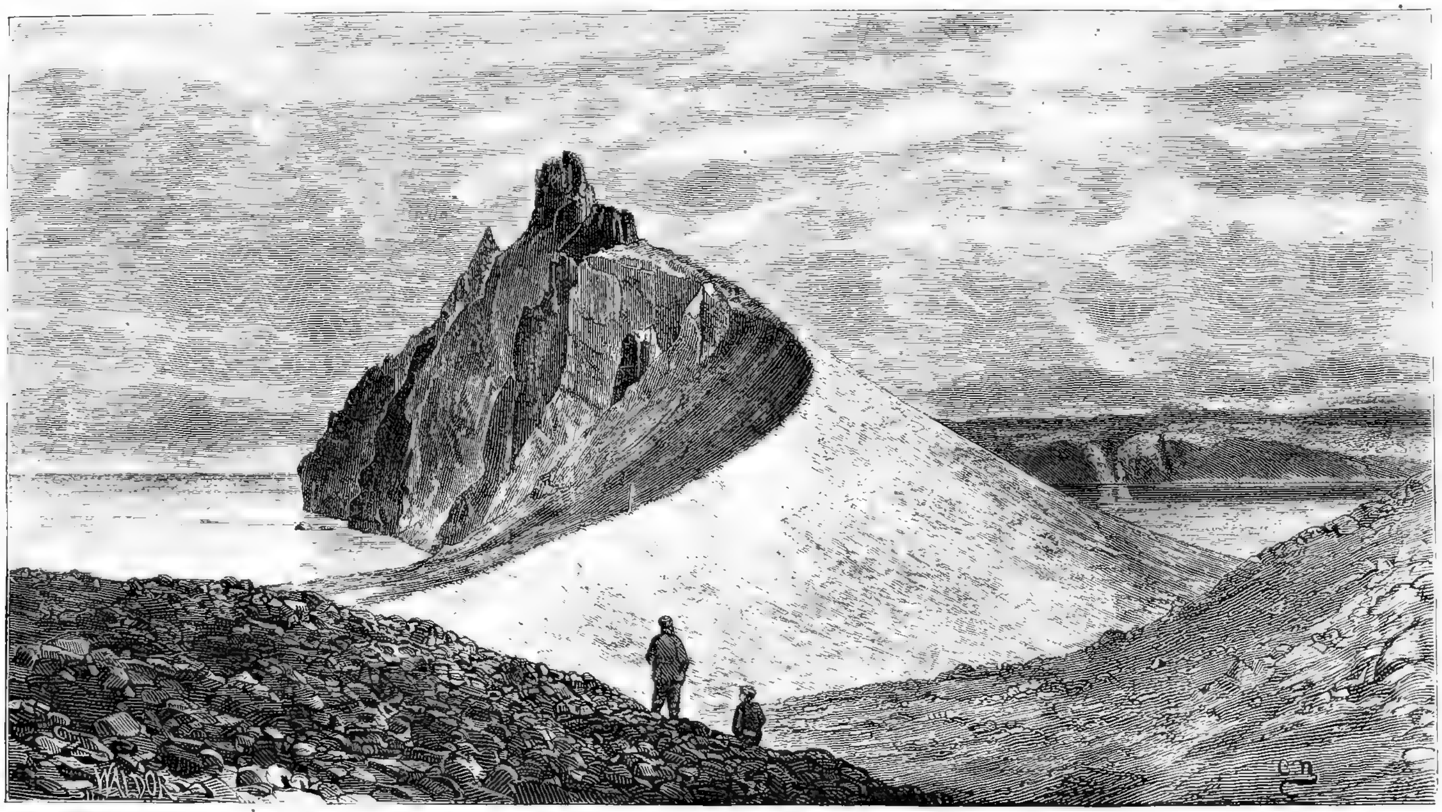


Fig. 1. Fugleberget. — The Fugleberg, or Fowling-Cliff.

Siden af Fugleberget, længere mod Syd, laa en flad Sandstrand, tæt bestrøet af Rækved. Her gik vi i Land uden den ringeste Vanskelighed. Stranden bestod af sort Sand. Den største Del af Rækveden laa paa en fra Havbredden noget tilbagetrukket Slags Terrasse, hvis horizontale Flade fandtes 5 til 6 Meter over Havets Niveau. Den mindre Del laa paa den foranliggende Skraaning mellem Terrassen og Stranden. Derfor ser det i Frastand fra Søen ud, som om Rækveden laa opstablet i regelmæssige Lag paa Stranden.

"Fugleberget" viste sig at være — som det sees af Figur 1 — Østsiden af et Krater, hvis vestlige Del er styrtet i Havet. Det er bygget af Lag af Tuf, fast Lava, udkastede Masser af Slakker og Aske. Paa den søndre Side af Mary Muss Bugten hævede sig, nær Søen, et mindre kegleformigt Krater (Krater Blytt), og indenfor dette, nærmere Øens Midte, et noget større af samme Form (Krater Danielssen), hvis Top nu ragede op i Taagen, men som

reminded us of Ystiklettur on the Vestmanna Islands. Stretching south of the Fugleberg, lay a flat sandy beach, bestrewn with driftwood. Here we landed, without the slightest difficulty. The beach was of black sand. Most of the driftwood lay on a terrace-like ledge, the level surface of which extended from 15 to 20 feet above the sea; the remaining portion was scattered over the gentle slope between the ledge and the beach. Thus, from the sea the driftwood appears at some distance to be piled along the shore in regular layers.

The "Fugleberg" (see Fig. 1) was found to be the eastern side of a crater whose west part had toppled down into the sea. It is built up of stratified tuff, compact lava, discharged masses of cinders, and ashes. On the south shore of Mary Muss Bay, in close proximity to the sea, rose a smaller, conical-shaped crater (Blytt's crater), and farther inland, towards the middle of the island, another of similar form, but somewhat larger (Danielssen's crater),

en af de følgende Dage saaes klart fra Øens Østside. Ved at stige op saa højt som Taagen tillod mig (175 Meter), fandt jeg Keglen bestaaende af lutter løse, udkastede, afrundede røde Stene samt sort Aske.

Ved Opstigningen fra Mary Muss Bugten naaede jeg, mellem Fugleberget og de to nævnte Kratere, meget snart op til Højderyggen af Øen, der her er paa sit laveste og smaleste. Fast lysgraa Lava, jevnlig blæret i Overfladen, dannede her Bergarten. Denne er, ifølge en senere Undersøgelse,[1] i meget ringe Grad, næsten umerkelig, magnetisk, medens en tættere, mørkere Lava, med indesluttede større Krystaller af indtil flere Millimeters Gjennemsnit og af basaltisk Udseende, der fandtes paa flere Steder, er tydelig polar magnetisk. Det laveste Parti af denne Højderyg fandtes efter Maaling med Aneroidbarometer at være 66 Meter. Højderyggen afluttedes paa den anden Side, mod Sydost, af en brat Styrtning. Under denne laa et udstrakt lavt Forland, der danner den indre Begrændsning af den lange, østlige Lagune. Mod Øst saaes fra Højden

its summit shrouded in mist, of which however we got on one of the following days an excellent view from the east side of the island. On clambering up as far as the fog would admit (570 feet), I found the cone to be exclusively composed of reddish, rounded, cindery stones ejected from the crater, and ashes.

Making the ascent from Mary Muss Bay, I soon reached — between Fugleberg and the two above-mentioned craters — the chief mountain ridge of the island, where its breadth and altitude are least. Here, compact light-grey lava, cellular at the surface, constitutes the outer stratum of rock. According to a subsequent examination,[1] this substance is very slightly, nay well-nigh inappreciably magnetic, whereas a denser, darker-coloured lava containing large crystals, — some of which measure several millimetres in diameter, — and of basaltic appearance, that occurred in several localities, has a perceptible magnetic polarity. The least elevated section of the ridge was found, from observations with the aneroid barometer, to reach an altitude of 217 feet. The ridge terminates on the opposite side of the island, towards the south-east, in a

Fig. 2. Ægøen. — Egg Island.

[1] Foretaget af Prof. Schiötz.

[1] By Professor Schiötz, of Christiania University.

den i Havet udstikkende Halvø "Ægoen" med sin "Kalv" (Fig. 2). Mod Sydost saaes under Taagen Jan Mayens Syd-Lands Østkyst, med Lagunen og dens Vold, og de frit staaende af Havet opragende Bergknauser "Lodsbaaden" og det fjernere "Fyrtaarnet". Hr. Schiertz's Billede giver en udmerket Forestilling om dette Parti. Til Grund for samme ligger en Skitse taget fra Højderyggen Da Taagen, som nævnt, denne Dag dækkede Højderne, ere disse tilføjede efter de fra Ankerpladsen paa Østsiden et Par Dage senere tagne Skitser.

Mod Nord kunde ingen fremtrædende Træk i Landskabet sees under Taageranden. Paa Tilbagevejen til Landingspladsen fulgte jeg en liden Bæk mellem de to nævnte Kratere i Syd for Mary Muss Bugten. Den forsvandt i Sandet forend den naaede Havet. Fra dette Punkt tegnede jeg Skitsen til Fig. 1, der viser "Fugleberget" fra Siden, til Venstre af samme Havet, til Højre den vestlige Lagune.

Samme Formiddag samlede Dr. Danielssen Planter paa Højderyggen og paa Skraaningen af det større Krater (Krater Danielssen) i Syd for Landingspladsen. En Polarræv, der blev opjaget paa Højderyggen eller Ejdet, blev skudt med Expressrifle af Lieutenant Petersen.

Det rolige Vejr vedvarede om Eftermiddagen, og nye Excursioner foretoges i Land. Fra Landingspladsen gik jeg først over den indre og ydre Skraaning af Fuglebergets Affald mod Sydost, og derpaa tilvenstre i Dalen indenfor Fugleberget, indtil jeg naaede den vestlige Lagune. For at komme fra Lagunens sydlige Strand hen til den Tange, som skiller den fra Havet, maatte jeg passere en Ur af tildels store skarpkantede Lavablokke, der her danner Overfladen af "Fuglebergets" mod Lagunen vendende Fod. Lagunen har ferskt Vand. Den er saa dyb, at Bund ikke kunde sees paa en kort Afstand fra Stranden.

Tangen, som skiller Lagunen fra Havet, var 200 Skridt (140 Meter) bred. Dens højeste Ryg laa, efter Maaling med Aneroidbarometer, 8 à 9 Meter over Havets Niveau. Lagunvandets Niveau laa 5 à 6 Meter under Tangens Ryg, eller omtrent 3 Meter højere end Havets Niveau. Paa Tangen laa megen Rækved og mange Hvirvler og Kjæver af Hval. Der fandt jeg ogsaa et Flotholt, c. 10 Cm. langt, 7 Cm. bredt, 2 Cm. tykt, af Bark. Forskjellige Stykker bredbladet Tang laa opskyllede paa Yderkanten af samme Vold. Dennes Længde ansloges til en Kvartmil og Lagunens Bredde til henimod det samme. Der saaes Rækved liggende ogsaa paa Lagunens søndre,

steep declivity, beneath which stretches a broad expanse of low-lying foreshore, forming the inner boundary of the long eastern lagoon. Looking east from the heights above, I had before me the "Ægoen" (Egg-Island) peninsula, with its "calf" — small detached islet (Fig. 2). In the south-west, we could sight beneath the fog the east coast of the southern part of Jan Mayen, with the lagoon and its barrier, and, rising abruptly from the sea, two isolated rocks, known as "Lodsbaaden" (the pilot boat) and "Fyrtaarnet" (the lighthouse). Mr. Schiertz has given in the plate an excellent view of this fine coastal scenery, sketched from the ridge overlooking the sea. The mountain summits having, as previously remarked, been wrapped in clouds on our arrival, that part of the picture was filled in from sketches taken a day or two later from our anchorage on the east side of the island.

North, no prominent feature of the scenery could be discerned below the fog. On my way back to the landing-place, I followed the course of a rivulet between the two craters south of Mary Muss Bay. Before reaching the sea, this little stream was lost in the sand; and here I sketched the "Fugleberg" — a side-view, to the left the ocean, to the right the western lagoon (Fig. 1).

The same afternoon Dr. Danielssen collected specimens of the insular flora on the mountain ridge and on the slope of the great crater (Danielssen's crater), south of the landing-place. A polar fox, roused, I believe, among the rocks of the mountain ridge, or on the isthmus, was shot by Lieutenant Petersen with an "Express" rifle.

The weather still continuing fine, further excursions were made in the afternoon. From the landing-place I took a south-easterly direction, crossing the south-western ridge of the Fugleberg, and then, turning to the left, struck off down the valley on the shore-side of the cliff, till I came to the western lagoon. In making my way from the south shore of the lagoon to the strip of land stretching between it and the sea, I had to pass an incline of debris over part of which were dispersed large, sharp-edged blocks of lava, that hereabouts form the base of the fowling-cliff on the side facing the lagoon The water of the lagoon is fresh, and apparently of considerable depth, since the bottom could not be discerned at a short distance from shore.

The barrier separating the lagoon from the sea measures 200 paces (460 feet) across. Its highest ridge, as determined from observations with the aneroid barometer, attains an elevation of 28 feet above the level of the sea. The surface of the water of the lagoon lies 18 feet lower than the ridge of the barrier, or about 10 feet above the level of the sea. On the barrier there was a good deal of driftwood, along with the vertebræ and jaws of whales. There, too, I found a float of bark, about 4 inches long, 3 inches broad, and 3/4 inches thick. Divers fragments of broad-leafed seaweed had been washed on to the outer slope of the barrier. The length of the latter

indre Strand. Luftens Temperatur var 4° og Vandet i Lagunen var + 4.°3.

Under Tilbageturen sad min Ledsager, der havde Hagelgevær med, og jeg og hvilede i Uren ved Lagunens Bred. En Ræv kom frem af Uren, betragtede os nysgjerrig, gik oven om rundt om os og saa udover Lagunen. Paa mit Vink havde imidlertid min Ledsager ladet Geværet og rakt mig det. Blandt de fra denne Excursion medbragte Specimina var et i Uren skudt Exemplar af *Canis lagopus*. Det 3die Exemplar blev skudt af Capt. Wille samme Eftermiddag paa Stranden i Mary Muss Bugten, hvor Matroserne havde opgjort et Baal af Rækved, der syntes at hidlokke Rævene.

Hr. Tornøe gik samme Eftermiddag langs den indre Side af Lagunen. Ved dens nordøstre Hjørne fandt han en Bæk (Tornøes Bæk), der løb ud i Lagunen. Fra den søndre Strand af Lagunen førte en lavtliggende Dal, kanske det laveste Ejd paa hele Øen, ham over til Østkysten, hvor han steg ned ad den bratte Skraaning og vandrede hen til

I estimated at an English mile, and took the breadth of the lagoon to be about the same. Driftwood lay scattered over the southern (inner) strand of the lagoon. The temperature of the air was 4°, that of the water in the lagoon 4.°3.

On our way back to the boat, as I and my companion, who carried a fowling-piece, were resting on the tract of debris that borders the shore of the lagoon, a fox made its appearance among the stones, and, after regarding us a moment with evident curiosity, passed quietly on, within good range, in a circuit above us, and looked out across the lagoon. I motioned my companion to load and hand me the gun. Among the specimens collected on this excursion was an example of *Canis lagopus*. Another specimen of this animal was shot the same afternoon by Capt. Wille on the shore of Mary Muss Bay, where the sailors had lighted a pile of driftwood, which seemed to attract the foxes.

Mr. Tornoe strolled along the land-side of the lagoon, flowing into which, at the north-eastern extremity, he found a small stream (Tornoe's rivulet). From the south side of the lagoon, a deep-lying valley, perhaps the lowest part of the island, took him across to the eastern shore, whence, descending the steep incline, he made his way to the long

Fig. 3. Det Brielske Taarn. — Brielle Tower.

den lange Lagune. Ogsaa her var Vandet ferskt, men Lagunen var meget grundere end Vestsidens. Der laa Rækved, saavel paa Lagunvolden som paa den indre Strand.

Den følgende Dag arbejdede Zoologerne med Skrabning fra Baad i Mary Muss Bugten. Fra vor Ankerplads toges Skitser, navnlig af Landet mod Vest. Disse ligge til Grund for Fig. 3, der viser Udseendet af det Nes, der begrændser Nordostsiden af Nord-Baj eller English Bay. Yderst ser man den isolerede høje Klippe, som af de gamle Hollændere er kaldt "Brielle-Taarnet" og som danner et udmerket Somerke. Mellem "Taarnet" og Landet indenfor er en dyb Kloft, som paa de ældste Karter kaldes "Walrusch Gat". Billedets Synspunkt er tænkt paa den vestlige Laguntange, strax i Nordost for Fugleberget, hvis bratte Skrænt sees til venstre i Forgrunden. Brielle Taarnet ligger tre Gange saa langt borte som "Vøringen".

Da vi om Eftermiddagen gjorde os istand til at gaa i Land for at undersøge Landet længere sydpaa, rejste sig en frisk Bris af Nordvest, der satte saa megen Sø, at Landgang blev vanskelig. Det besluttedes da at sejle om til den anden Side af Øen. Under Letningen kom Solen et Par Gange frem i Vest, saa at dens Højde kunde maales. Paa den anden Side, mod Nordost, rev Vinden enkelte Gange Hul i Taagen, og Toppen af Beerenberg viste sig i nogle Secunder, ophøjet og vidunderlig skjøn i sin blændende hvide Snekaabe. Dens Højde blev maalt med Sextant. Vi styrede NNV. over. Saa ofte som Beerenberg var synlig, benyttedes de korte Stunder til at fæste dens Udseende i Skitsebogerne. Efter disse Skitser er Fig. 4 tegnet. Forholdet mellem de verticale og horizontale Udstrækninger er det rigtige og stemmer med Kartet. Store sorte Flekker, paafaldende morke ved Contrasten med den blændende hvide, af Solen oplyste Sne, viste bratte Styrtninger paa den øvre Kegle, hvor Fjeldet var ganske bart. Da vi kom længere frem, stak to Afsatser, den ene udenfor (nordenfor) og nedenfor den anden, sig frem mod Nord — se Fig. 4 — saa kom Taagen og tilhyllede atter alt undtagen det laveste af Landet til 90 à 100 Meters Højde.

Under hele Farten denne Eftermiddag og Aften rundt Øens Nordende toges stadig Pejlinger med Compasset til alle synlige Pynter og andre merkelige Gjenstande, og der maaltes Vinkler med Sextant. Ogsaa til Punkter paa Sydlandet, der under den forste Del af Farten saaes helt nede indtil Hoyberg, toges Sigter. Kursen styredes og beregnedes med Nøjagtighed og Loggemaskinen observeredes hvert femte Minut. Der toges ved Siden heraf en Række Skitser. Det saaledes indvundne Materiale er i fuldt Maal

lagoon. Here, too, the water was fresh, though the lagoon was much shallower than that on the west side. Driftwood lay scattered alike on the barrier and on the inner strand.

On the following day our zoologists dredged from a boat in Mary Muss Bay. Sketches were made from the anchorage, chiefly of the land stretching west; and these have furnished the subject of Fig. 3, which gives a view of the headland forming the north-eastern extremity of North or English Bay. In the distance is seen the lofty isolated rock called by the early Dutch navigators "Brielle Tower," and which serves as an excellent land-mark. Between the "Tower" and the main land extends a deep ravine, that bears on the earliest maps the name of "Walrusch Gat." The point of view in the figure is supposed to be on the barrier of the western lagoon, north-east of the Fugleberg, which, with its steep acclivity, rises boldly in the left foreground. The distance of Brielle Tower from the point of view is thrice that of the "Vøringen."

In the afternoon, as a party of us were getting ready to go ashore, with a view to explore the island farther south, a fresh breeze sprang up from the north-west, and soon made so rough a sea that landing was out of the question. We determined therefore to steam round to the opposite side of the island. While getting under weigh, the sun broke out twice in the west, and we managed to take a couple of altitudes. Now and again, on the other side, in the north-east, the wind tore a rent in the clouds, and for a few seconds disclosed the dazzling, snow-capt summit of Beerenberg, in matchless grandeur and beauty. The height of the mountain was measured with the sextant. We steered north-north-west. So often as any part of Mount Beerenberg became visible for a moment, the brief opportunity was eagerly seized to fix some new feature of its fleeting aspect. Fig. 4 is from these sketches. The proportion between the vertical and the horizontal extent of the mountain is true to nature, and agrees with the Map. Huge black patches on the upper cone, rendered doubly conspicuous by contrast with the dazzling white of the sun-illumined snow, showed the position of the steepest inclines, where the mountain was entirely naked. Farther on, two rocky ledges, the one beyond (north of) and below the other, could be seen projecting northward (Fig. 4): — and then came the fog, blotting out everything from view, save the lowest strip of coast, that was still visible for about 300 feet above the sea.

During the whole of that afternoon and evening, as we steamed round the northern extremity of the island, bearings by the compass were successively taken of all visible headlands and other salient landmarks; and angles were measured with the sextant. Of points on the south part of Jan Mayen, that for some time after starting could be seen as far as Hoyberg, bearings were also taken. The ship's course was accurately computed, the water-log being observed every five minutes. Moreover, a series of sketches

blevet benyttet til Constructionen af det medfølgende Kart.

Paa Vestsiden af Beerenberg saaes nedimod Havet enkelte Sneklatter, men nogen Isbræ gik her ikke til Ha-

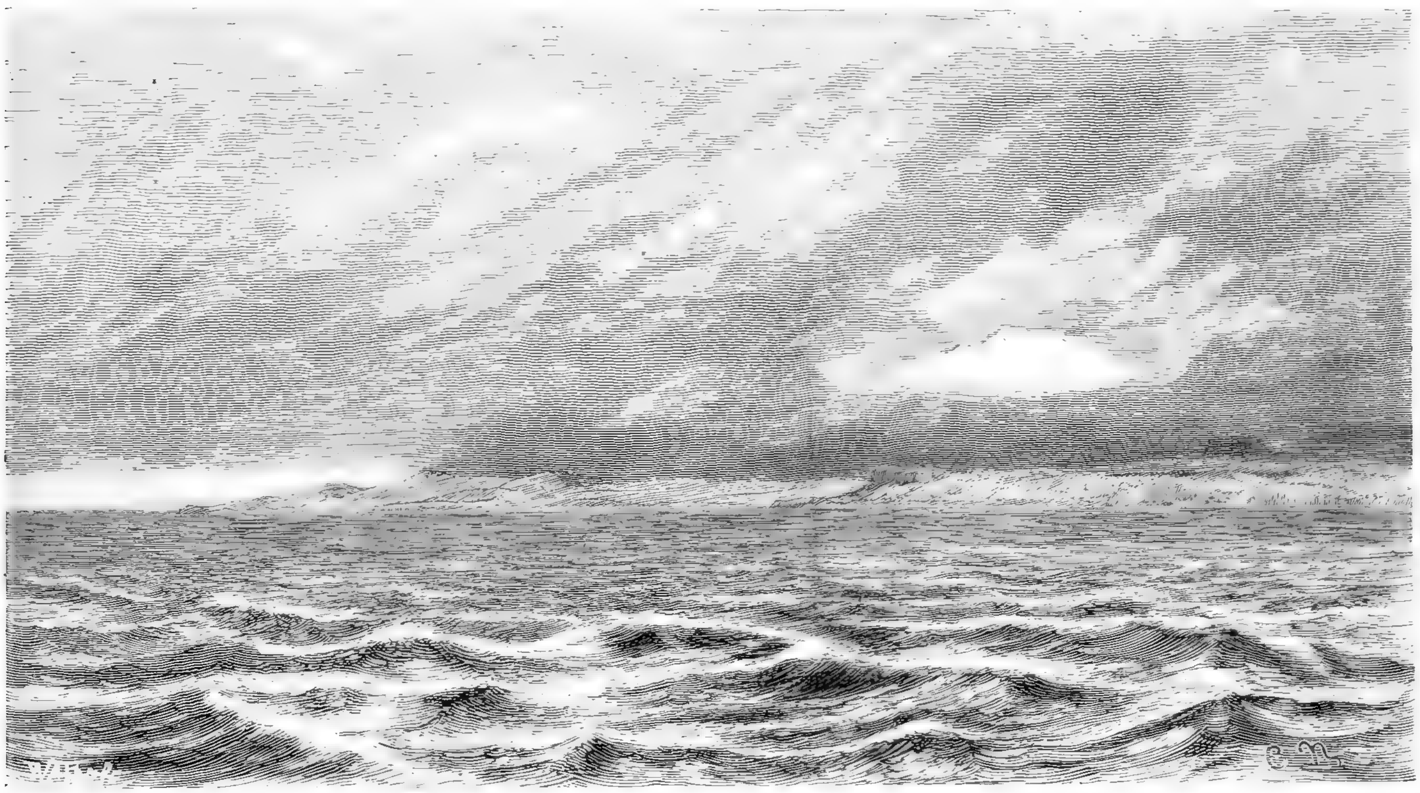


Fig. 4. Beerenberg fra Vest. — Mount Beerenberg, looking East.

vets Bred. Da vi vare komne paa Højden af Vestre Kors-Bugt, saa vi en stor Isbræ (Weyprechts Bræ), der skjod sig frem i Havet med en brat Ydervæg, og kort Tid efter viste sig en lignende, endnu større Isbræ (Kjerulfs Bræ). Den sidstes yderste bratte Væg var efter de anstillede Vinkelmaalinger 45 Meter høj. Bræerne kom frem under Taagen med en Overflade, der skraanede meget svagere end de stejle Bræer paa Østsiden. Jeg anslog Heldingen til c. 10°. Endnu en 3die Isbræ (Foyns Bræ) saaes østenfor den store. Den var mindre end de to andre. Da vi en af de følgende Dage atter passerede Nordsiden af Jan Mayen, laa Taagen højere, saa at vi bedre kunde se, hvorledes Nordsidens Bræer komme frem af dybe Indskjæringer i den 300^m høje, bratte Fjeldvæg, der her, ligesom paa Østsiden, danner Beerenbergs Fod ud mod Havet. Billedet Fig. 5 viser de 3 Bræer paa Nordsiden, saaledes som vi saa dem. Foran ligge opstablede Volde. Bræen selv er tagget og kløftet og belagt med Smuds og det Hele af-

were made of the coastal scenery. The various topographical and other data collected on this occasion, have been duly applied for the construction of the annexed Map.

On the west side of Mount Beerenberg, approximating the sea, lay a few patches of snow; but no glacier extended in this locality to the shore. Off West Cross Bay, we saw a large glacier (Weyprecht's glacier), jutting into the sea, with a steep outer wall; and shortly after another came in sight (Kjerulf's glacier), of still more imposing dimensions, its precipitous outer wall being found by trigonometrical measurement to attain an elevation of 150 feet. The glaciers here, as seen beneath the mist, had the slope of their surface much more gradual than the precipitous glaciers on the east side. I estimated the incline at about 10 degrees. A third glacier (Foyn's glacier) was sighted east of the large one. It was smaller than the other two. On one of the following days, as we again coursed along the northern shore of Jan Mayen, the clouds lay higher, affording a better view of the coast; and on this occasion the glaciers could be distinctly seen, projecting from deep clefts in the abrupt mountain-wall, which attains an altitude of 900 feet, and here, as on the east side, forms the seaward base of Mount Beerenberg. Fig. 5 gives a view of the 3

giver et meget vildt Skue. Vi passerede i en Afstand af $2^1/_3$ Kvartmil.

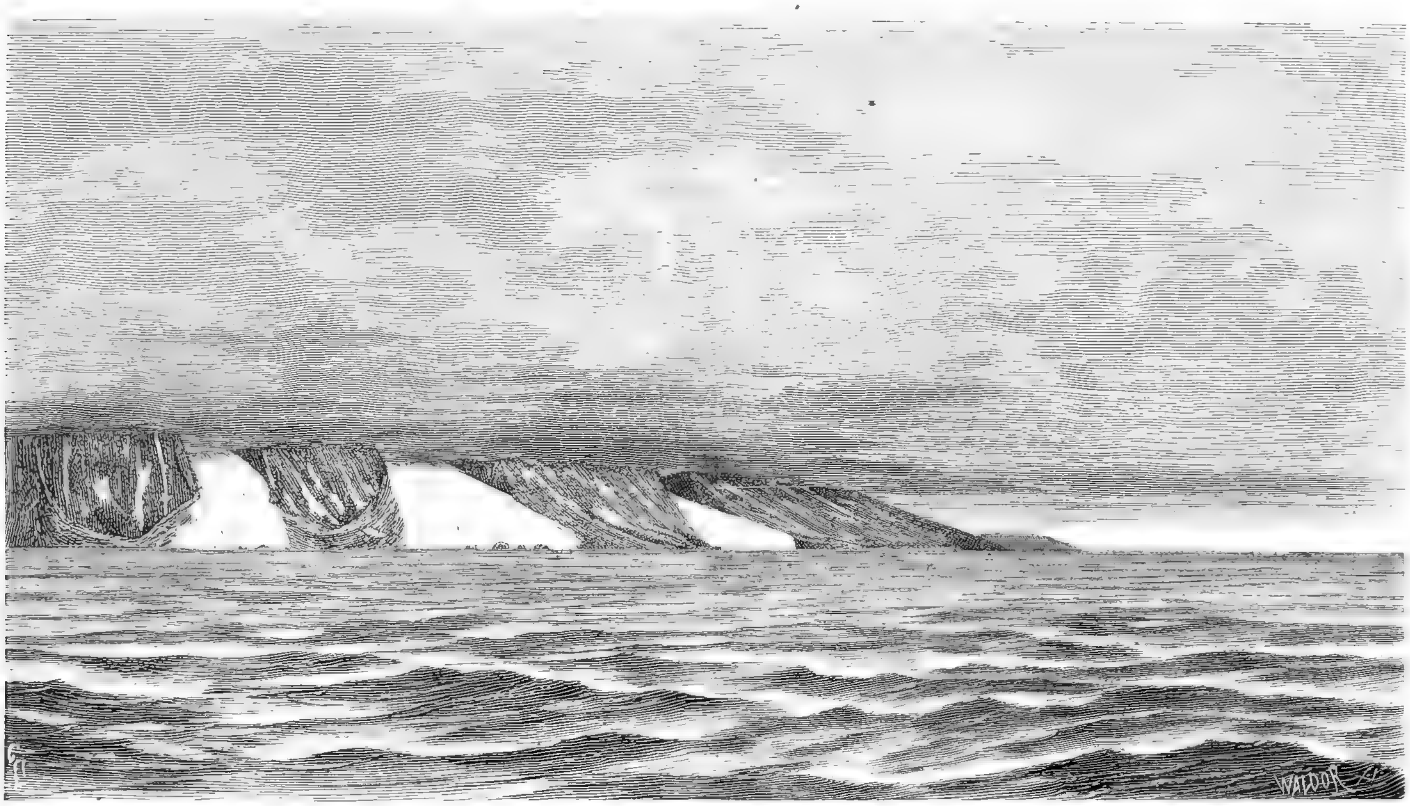


Fig. 5. Nordsidens Bræer. — The Glaciers of the North Coast.

Kl. 9 om Aftenen passerede vi Nordostkap. Vi kunde nu se Rækken af de stejle Bræer paa Østsiden. Der var ikke flere end 5 saadanne, som naaede Havfladen. Deres indbyrdes Beliggenhed bestemte jeg ved at notere de Øjeblikke efter Uret, da hver af dem observeredes tvers paa Kursen, der holdtes uforandret og med jevn Fart. Kl. 12,45 Min. om Morgenen ankrede vi i den store Rækved-Bugt paa 12 Favne Vand, udenfor Lagunen, i Vest for Ægøen.

Denne Dag, den 31te Juli, bleve vi liggende paa vor Ankerplads. Taagen fordelte sig noget, saa noget mere af Landet blev synligt; men Beerenberg var fremdeles tilhyllet. Derimod var Solen jevnlig fremme om Formiddagen og en Del af Eftermiddagen. Da Søgangen hindrede Landgang, toges Solhøjder fra Skibet.

Om Eftermiddagen forsøgtes Landgang med to Baade, men Brændingen var for svær til at man turde vove Forsøg paa at bringe Instrumenter i Land. Vi roede langs Lagun-

glaciers on the north side as they appeared to us. In the foreground lie prodigious rampart-like masses of debris; the glaciers, too, are jagged and riven, and discoloured with dirt; altogether it is a wild scene. We passed at the distance of two and one-third miles.

By 9 o'clock in the evening we had rounded Cape North-East; and now the series of precipitous glaciers on the east side of the island came in sight. Only 5 of these reached to the water's edge. Their relative position I determined by noting, watch in hand, the exact moment at which each was observed abreast of the vessel, keeping the same course and speed. At 12.45 a.m. we cast anchor in Great Wood Bay, in 12 fathoms, off the lagoon lying west of Egg Island.

The rest of the day, July 31st, we passed at our anchorage. The fog dispersing a little, more could be seen of the land; Mount Beerenberg, however, was still wrapped in clouds. Meanwhile, we had the sun out most of the fore part of the day, and at intervals in the afternoon. The swell being too heavy to admit of landing, a series of solar altitudes was taken from the ship.

In the afternoon two boats put off for the shore; but there was too much surf to risk landing the instruments. We rowed along the barrier of the lagoon to Egg Island,

volden, hen til Ægøen og udenom denne. Der, hvor Lagunvolden støder til Foden af Ægøen, saa vi Snelag, dækkede af sort Sand. Vi fik den følgende Dag, som det nedenfor vil sees, en simpel Forklaring paa dette Forhold. Ægøens Sider ere overalt mod Søen ganske stejle. Paa Sydvestsiden saaes i den tverbratte Væg et udmerket tydeligt Profil af de Aske- eller Tuf-Lag, hvoraf Øen, eller nu rettere Halvøen, er dannet. Ved svage Vindstød ramlede Dele af Asken los og styrtede som Ras ned i Fjæren eller i Havet, eller hvirvledes af sterkere Vindstød op til høje Røgskyer. Ægø-Kalven er et løsrevet eller tilbagestaaende Stykke af Ægøens Krater, bestaaende ligesom hele Øen af sort Tuf, der indeslutter større og mindre Stene. I Ægø-Kalven saaes Stene af indtil en Meters Tvermaal. Ægøens Krater er nu aabent mod Sydost, den ydre Del er begravet i Havet. Et Snit gjennem Ægøen fra NW—SE viser paa den mod Land vendende Side Lag af Aske, der, parallele med Overfladen, helde mod NW. Henimod Krateret derimod helde Lagene ned mod dette, mod SE, og inde i Krateret ser man paa dettes bratte Vægge det udgaaende af disse Lag som horizontale Belter.

Da vort Forsøg paa at komme i Land havde vist sig frugtesløst, skred vi til at bestemme Beliggenheden af vor Ankerplads i Forhold til fremtrædende Punkter paa Land ved trigonometriske Operationer. Ved Ægø-Kalven maalte jeg med Sextant Højden af Stortoppen paa "Vøringen". Da vi vare komne tilbage til Fartøjet, rejste Capt. Wille ud i Baaden, hvorfra han, liggende i en passende Afstand og Retning, maalte Vinkelhøjden af Stormasten, og derpaa Horizontalvinkelen mellem Stormasten og det Punkt, hvis Beliggenhed skulde bestemmes, i samme Øjeblik som jeg, staaende ved Stormasten, paa givet Signal maalte Horizontalvinkelen mellem Captein Wille og Punktet. Paa denne Maade bestemtes Afstandene til Ægø-Kalven, til Fugleberget paa Vestsiden, hvis markerede Top (se Fig. 1) var synlig over det lavere Ejde, og til Klippen "Lodsbaaden". Fuglebergets Azimut bestemtes af Skibets Officierer ved 3 Compaspejlinger paa 3 forskjellige Kurser, og Horizontalvinklerne mellem dette Punkt og de øvrige observeredes. Fra Fuglebergets Fod havde jeg den Dag, vi vare i Land, maalt Stormastens Vinkelhøjde og Skibets omtrentlige Azimut. Saaledes vandtes et efter Omstændighederne godt Grundlag for Øens Kartlægning. Samme Dag toges mange Skitser. Sydlandets Udseende kunde nogenlunde opfattes; dog vare de højeste Partier hverken nu eller senere under vort Ophold fri for Skyer. Vort store Billede med Lagunen viser Sydlandets Østside meget nær saaledes som det saaes fra Ankerpladsen.

and some distance round. Where the barrier of the lagoon abuts on Egg Island, we saw layers of snow covered with black sand. The next day, as will appear below, a simple explanation was obtained of this phenomenon. The sides of Egg Island are exceedingly precipitous towards the sea. On the south-west side, the well-nigh perpendicular wall of the cliff exhibited with remarkable distinctness the strata of ashes, or tuff, of which the island, or now rather the peninsula, is composed. A puff of wind brushing the surface sufficed to loosen and blow about the ashes, some falling on the beach or into the sea, while a violent gust would whirl them aloft in clouds. The Egg Island calf (detached islet) is a disrupted fragment of the Egg Island crater, consisting, as does the whole of the main island, exclusively of black tuff, in which are imbedded larger and smaller stones. In the tuff of the islet were seen stones measuring as much as 3 feet across. The Egg Island crater is now open towards the south-east, the outer portion lying buried in the sea. A vertical section through the island from NW. to SE. exhibits on the land side layers of ashes, which, running parallel to the surface, incline towards the north-west, but, as they approach the crater, turn off towards it, dipping in a south-easterly direction, and within, on the precipitous walls of the cavity, make their appearance as broad horizontal bands.

The attempt to land having proved abortive, we now set about determining the relative position of our anchorage and that of salient points on shore, by means of trigonometrical observations. Off the Egg Island calf, I measured with the sextant the height of the main mast of the "Vøringen." On our return to the ship, Captain Wille put off in a boat, from which, in the proper direction, he first measured the angle of elevation of the main mast, and then the horizontal angle between the main mast and the point the position of which had to be determined, whilst I, stationed beside the main mast, at a given signal, simultaneously measured the horizontal angle between the boat and the point. In this manner were determined the respective distances of the Egg Island calf, of the Fugleberg, on the west side, the conspicuous summit of the cliff (see Fig. 1) being visible above the low-lying isthmus, and of the "Lodsbaaden," or pilot-boat rock. The azimuth of the Fugleberg was taken by the officers of the vessel, from 3 compass-bearings on 3 different courses, and the horizontal angles between that point and the other landmarks were observed. From the foot of the Fugleberg, I had taken the day we were on shore the angle of elevation of the main mast, together with the approximate azimuth of the ship. We thus, considering the circumstances, succeeded in obtaining a fair collection of data for constructing a map of the island. The same day numerous sketches were made of the coastal scenery. The contours of the southern land could be discerned with tolerable distinctness; but neither on this nor any subsequent occasion during our stay were its loftiest tracts visible. The large plate with the lagoon shows the east side of the southern land very nearly as it appeared from the anchorage.

Den følgende Dag, 1ste August, fik jeg om Formiddagen nogle Solhøjder fra Ankerpladsen. Vi lettede og stod sydover, loddede og skrabede paa 70 og 95 Favnes Dyb (se Kartet). Bunden var sort vulkansk Sand og Slik og Dyrelivet rigt; Vandet ved Bunden havde en Temperatur under 0°. Over Jan Mayens Sydland laa Taagen fremdeles og skjulte de øverste Dele, men over Nordlandet spredte Skyerne sig efterhaanden, saa at vi hele Eftermiddagen og Aftenen havde det herlige Syn af Beerenberg i fuld Solbelysning. Selvfølgelig vare alle Tegnere i fuld Virksomhed. Fra den nordligste af de paa Kartet med 95 Favnes Dyb betegnede Stationer tog jeg en Række Maalinger af Beerenberg: Horizontalvinkler og Højdevinkler med Sextant, Heldningsvinkler med det til mit geologiske Compas hørende Klinometer, samt flere Skitser. Dette Material er benyttet til Tegningen af mit Billede af Beerenberg.

Til Venstre ser man den sorte Ægø i lidt over 6 Kvartmils Afstand, det nærmeste Object. Havhorizonten ligger i lidt over 4 Kvartmils Afstand fra Øjet, og alle Strandpartierne dukke følgelig under denne. Til Højre for Ægøen sees Kraterne Esk og Vogt, begge med sine kløftede Kraterrender. Mellem Krater Vogt og det spidsere Fjeld (Scoresby's Berg) til venstre for samme, der ligger lige op for Østkanten af Ægøen, synes en Dal med en Bergmasse, der skraaner mod Vest og hvis Fod var synlig fra Ankerpladsen, maaske en Lavastrøm. Dens Farve var mere blaalig, medens Kraternes er rødlig. Østenfor Krater Vogt saaes, mindre tydelig, nogle Højder under Beerenbergs Fod, indtil man kommer til den store Sydbræ, der i en Bue gaar ned fra Snegrændsen til Havet. Partiet mellem Sydbræen og Sydostkap frembød i den betydelige Afstand, 9 til 12 Kvartmil, ikke mange Detaljer. Lige øst for Sydbræen kunde jeg se en Højde eller en Højderyg, der syntes at ende i et Fremspring i Havet, Scoresby's Cape Fishburn. Som man ser af Billedet, kunde Snegrændsens gjennemsnitlige Beliggenhed bestemmes med en ikke ringe Nøjagtighed. Dens Højde beregner jeg efter mine Maalinger til 706 Meter over Havet. Over Snegrændsen sees Beerenbergs Snekaabe, der dækker hele den øvre Del af Fjeldets Basis. Denne Basis er en flad Kegle; dens Skraaning maaltes paa Vestsiden til 8° og paa Østsiden, ned mod Sydostkap, til 10°.

Over Basiskeglen, der rækker op til en Højde af c. 1400 Meter, hæver sig Beerenbergs Askekegle med en ydre Skraaning af 42°. Denne fremtræder ren paa Vestsiden, medens der paa Østsiden skyder frem fra Keglen nogle Ribber, antagelig Lavagange gjennem Keglen, der reducere den apparente Skraaning til 32°. Paa Vestsiden maaltes, fra den 8° heldende Basis af, et længere Stykke med 15° Heldning, derpaa et kortere Stykke med 28°

On the following day, August the 1st, I took in the forenoon a few solar altitudes from the anchorage. We then got under weigh and stood south, sounding and dredging in 70 and 95 fathoms (see Map). The bottom consisted of black volcanic sand and ooze; and there was abundance of animal life. The bottom-temperature was below 0°. Over the southern part of Jan Mayen the fog still lay heavy, obscuring the most elevated tracts; but over the northern part the clouds were gradually dispersing, and throughout the afternoon and evening we had a magnificent sun-lit view of Beerenberg. All who could draw were now of course fully engaged in sketching the scenery. From the most northerly of the observing-stations at which the depth, as indicated in the Map, was 95 fathoms, I took a series of measurements of Mount Beerenberg, — horizontal and vertical angles, with the sextant, angles of inclination, with the clinometer belonging to my geological compass, and made besides several sketches. The material thus acquired has been carefully worked up for my prospect of Mount Beerenberg.

On the left-hand side, distant upwards of 6 miles, the black wall of Egg Island, the nearest object in the picture, is seen boldly projecting. The distance of the horizon being a little more than 4 miles from the point of view, all parts of the shore dip beneath it. To the right of Egg Island are seen the Esk and Vogt craters, with their jagged edges. Between Vogt's crater and the somewhat acuminate mountain to the left (Mount Scoresby) rising behind the eastern acclivity of Egg Island, extends a valley filled with a rocky mass, — possibly a current of lava, — the base of which was visible from the anchorage. This mass had a bluish tint, whereas the craters are of a reddish colour. East of Vogt's crater loomed a few summits at the foot of Mount Beerenberg, and farther on was seen the great southern glacier shelving down in a curve from the snow-limit to the sea. At so considerable a distance as 9 to 12 miles, the tract between the southern glacier and Cape South-East did not present many prominent details. East of the southern glacier, I could distinguish a summit or mountain-ridge terminating apparently in a headland, — Scoresby's Cape Fishburn. As will be seen from the plate, the snow-line could be determined with very considerable accuracy. Its elevation I computed from my measurements at 2316 feet above the sea. At that height commence the snows of Beerenberg, which cover the entire upper portion of the base of the mountain. The base has the form of an obtuse cone, that on the west side was found to incline 8°, on the east, towards Cape South-East, 10°.

Above the lower cone, which attains an altitude of nearly 4600 feet, towers the cone of ashes, with its outer slope shelving at an angle of 42°. On the west side the slope has the surface smooth, but on the east exhibits a few prominent ribs, probably dykes of lava, which reduce the apparent incline to 32°. On the west side, from where the base of the mountain shelves at an angle of 8°, the slope for a good way up was found to be 15°, then for a

Heldning, og endelig selve Keglens Heldning paa 42°. Paa Østsiden sees Underdelens Skraaning paa 10° at skyde sig foran de fjernere, i Skygge liggende Partier, der staa ud som Ribber fra den geometriske øvre Kegle. Solen stod, da Kraterets Konturer og Skygger skitseredes, i Vest, i Papirets Plan.

Den stejle Kratervæg er paa mange Steder snefri, og den sorte Aske viser her store Flekker af ofte bizarre Figurer. Kraterranden er tagget, men Sneen, der dækker den, giver Randen med dens Tagger ejendommelig bløde Omrids. Kraterranden er højest paa Vestsiden; der maaltes en gjennemsnitlig Heldning af den øverste Linie af $2^1/_2$ Grad. Det højeste Punkt af Beerenberg ligger saaledes (nu) paa Kraterets Vestside og, som Fig. 4 viser, noget mod Nord. Det er dette Punkt, hvis Højde vi have søgt at bestemme med et rundt Tal til 1950 Meter.

Fra Loddestationerne toge Officererne Pejlinger til Øens nordlige og sydlige Del. At bestemme Skibets paaværende Plads efter Pejlingerne og Scoresby's Kart, viste sig omtrent ugjørligt, da dette, i Overensstemmelse med de ældre hollandske Karter, giver Sydlandet for langt og for smalt.

Medens vi vare paa Søen, havde vi Anledning til at iagttage de voldsomme Hvirvelvinde, der kunne blæse under Beerenberg. For et Sejlskib maatte disse være yderst generende med de pludselige Omslag i Vindens Retning under sterke Byger. I disse maaltes en Vindhastighed af 15 Meter pr. Secund, den største Vindhastighed vi iagttog under 1877 Aars Rejse. Fra Søen saa vi, hvorledes det fine Tufsand fra Ægøen reves løs og førtes højt op i Luften som en mørk Røgsky med de sterke Vindbyger. Med den vulkanske Ø for Øjne skulde der ikke nogen sterk Indbildningskraft til, for at man kunde tro at se Ildsluer bryde ud fra Ægøen og saaledes komme til at medbringe Efterretning om at have været tilstede ved et vulkansk Udbrud. Heldigvis havde vi Dagen før havt Anledning til at overbevise os om Sagens sande Natur. Om Aftenen ankrede vi i den store Rækvedbugt et Par Kvartmil i Sydvest for den forrige Ankerplads.

Næste Morgen, den 2den August, var Beerenberg fremdeles synlig. Vi lettede og stod østover, passerede Ægøen og loddede i 195 Favne udenfor Sydbræen. Paa Veien saa jeg tydelig inde paa Underlandet under Krater Vogt det af Carl Vogt i 1860 observerede og beskrevne lave Krater Berna. Fremdeles saa jeg, at Sydbræen gik lige til Stranden, men at dens nederste Del var bedækket med Smuds. Efter Lodningen gjorde vi et Forsøg til Bestemmelse af Højden af Beerenberg. Efter et godt Med (Ægøens Kant over et markeret Punkt inde paa Land) sejledes i en nøjagtig udmaalt Tid, medens Skibets Fart hvert 5te Minut observeredes efter Loggemaskinen. Ved Begyndelsen og Enden af dette Tidsrum maalte med Sex-

short distance 28°, the incline of the upper cone itself reaching, as previously stated, 42°. On the east side, the slope of the lower cone, that shelves at an angle of 10°, was seen extending before the more remote parts of the upper declivity, which lay in shadow, and like huge ribs project from the upper cone. When sketching the contours and shadows of the crater, I had the sun in the same plane as the paper.

The precipitous walls of the crater being in many places bare of snow, large patches of the black surface make their appearance, many of them grotesque in form. The ridge of the crater is extremely rugged; but the snow covering the jagged edges imparts a wonderful softness of outline. The ridge of the crater is highest on the west side; and its average incline was found to be $2^1/_2$ degrees. The most elevated point of Mount Beerenberg is accordingly (now) on the west side of the crater, and, as shown in Fig. 4, lies a little towards the north. It is this point the altitude of which we have approximately determined at 6400 feet.

From the sounding-stations, the ship's officers took bearings of points in the northern and southern parts of the island. To determine the ship's position from bearings and Scoresby's map proved well-nigh impossible, since the latter, based as it is on the earlier Dutch maps, gives the southern part of the island at once too long and too narrow.

Whilst engaged in sounding, we had opportunity of observing the violent whirlwinds that are often encountered on passing east of Beerenberg. To sailing-vessels they must prove a serious annoyance, owing to the sudden changes in the direction of the wind during heavy squalls. On one such occasion the velocity of the wind was found to reach 15 metres a second, the greatest velocity observed on the cruise in 1877. In the strong eddying gusts the fine tuff-sand of Egg Island would be caught and whirled aloft like a dense cloud of dust or ashes. With the volcanic island in immediate proximity, it required no great stretch of the imagination to fancy you saw flames bursting forth from the crater, and thus bring away the erroneous impression of having witnessed a volcanic eruption. Fortunately, we had had on the previous day opportunity of ascertaining the true nature of the phenomenon. In the evening we cast anchor in Great Wood Bay, a couple of miles south-west of our former anchorage.

Next morning, August the 2nd, Mount Beerenberg was still visible. We got under weigh, steering east, past Egg Island, and sounded in 195 fathoms, off the southern glacier. As we steamed along the coast, I could plainly distinguish on the low-lying tract beneath Vogt's crater the low Berna crater, observed and described by Carl Vogt in 1860. Moreover, I could follow the direction of the southern glacier to where it reaches the sea: its lower extremity was covered with dirt. After sounding, an attempt was made to determine the altitude of Mount Beerenberg. Selecting a good bearing (the base of the outer wall of Egg Island in a line with a salient inland point) we steamed ahead in this direction for a given time, accurately measured, the

tant, paa givet Signal, en Iagttager Vinkelen mellem Medet og Toppen, og en anden Iagttager Toppens Højde over Horizonten. Resultatet af Beregningen var 1945 Meter.

Om Eftermiddagen loddedes 340 Favne udenfor Sydostkap. Kursen sattes nu nordover. Taagen begyndte at omhylle Beerenberg og vi saa dens Top og Skuldre for sidste Gang. I Nordost for Nordostkap, 7 Kvartmil af, fandtes en Dybde af 1040 Favne. Dette giver en midlere Heldning af Havbunden udenfor Nordostkap af 8 Grader, hvilket er noget brattere end Heldningen af Beerenbergs Basis henimod Nordostkap (efter Kartet 6.°6), men mindre brat end Heldningen mod Sydostkap (10°). Paa Skraaningen ned mod Nordostkap saaes en Eruptionskegle (Krater Sars), som findes i ældre Tegninger, naar man ser nøje efter, saaledes i Vogt's Rejse og paa Lieutenant Ring's Tegning Fig. 7. Paa Nordsiden af Øen saaes de 3 Isbræer trædende frem af dybe Dale foran den bratte, 60° heldende, 300 Meter høje Fjeldvæg, Fig. 5. Hvad der laa højere, var dækket af Skylaget. Vi fik saaledes desværre ikke se Beerenberg og dens Grundstykke fra Nordsiden, og de store Bræers Udspring fra Snegrændsen gik ligeledes vor Iagttagelse forbi, da Taagen efterhaanden sænkede sig.

Efter at have taget en Række Lodskud i Nord og Nordvest for Jan Mayen, og fundet over 1000 Favnes Dyb paa vort vestligste Punkt, hvor Luftens Temperatur om Natten var kun lidt over Frysepunktet, men ingen Is var at se, styredes tilbage mod Øens Vestside. Da vi om Formiddagen den 3die August nærmede os Mary Muss Bugten, var Vejret fremdeles meget taaget. Vi styrede videre langs Landet sydvestover og spejdede opmerksomt efter en Lejlighed til at komme i Land paa Sydlandet, men forgjæves. Ofte tog Taagen Udsigten til Land ganske bort, og overalt saa vi Brændingen paa Stranden lige sterk som da vi forgjæves prøvede at lande paa Østsiden. Vi stoppede paa et Par Stationer og loddede — se Kartet — 98 og 156 Favne. Fra disse Stationer og fra flere andre Punkter fik vi gode Skitser af enkelte Partier af de lavere Dele af Sydlandet. Efter disse er saaledes Fig. 6 gjengivet. Man ser den regelmæssige Eruptionskegle Hoyberg ude mod Stranden. Længere inde, ved Guinea Bugten, dukker et lidet, men meget regelmæssigt kegleformigt Krater (Høsaaten) op af Lavlandet. Den lave Sydpynt vender lige mod Tilskueren. Bagenfor det foranliggende Lavland løfter sig med bratte Vægge Sydlandets Højfjeld. Oppe paa dette sees et kegleformet Fjeld (Krater Vøringen), et Krater efter al Sandsynlighed. De bratte Styrtninger mod Havet fortsætte lige til Cap Sydvest. Her er en naturlig Port i Fjeldet, gjennem hvilken Havet gaar. Udenfor Nesset sees de Syv Klipper med sine fantastiske Former.

speed of the ship being read off every five minutes on the scale of the water-log. At the beginning and the end of this interval, at a given signal, one observer measured with the sextant the angle subtending between the bearing and the summit of the mountain, and another the height of the summit above the horizon. The result of the computation was 6380 feet.

In the afternoon we sounded in 340 fathoms off Cape South-East, and then steered northward. Clouds had now begun to gather round Beerenberg, and we had our last view of the summit and upper part of the mountain. North-east of Cape North-East, 7 miles from land, the depth was 1040 fathoms. This shows a mean incline of the sea-bed off Cape North-East of 8 degrees, which slightly exceeds that of the base of Mount Beerenberg towards Cape North-East (according to the Map 6.°6), but is somewhat less than the slope towards Cape South-East (10°). On the north-eastern declivity was seen a parasitic cone (Sars's crater), which may be found in earlier views of the island if carefully looked for, for instance in a prospect in Vogt's Travels, and in one by Lieutenant Ring, Fig. 7. On the north side of the island the 3 glaciers could be seen jutting out from deep valleys beyond the precipitous mountain-wall, which is here 900 feet high and shelves at an angle of 60°, Fig. 5. Whatever lay at a greater elevation was wrapped in clouds. Unfortunately, therefore, we got no view of Mount Beerenberg from the north side of the island, and the origin of the glaciers at the snow-limit likewise escaped our observation, the fog having gradually descended.

After having taken a series of soundings to the north and north-west of Jan Mayen, and found a depth of more than a thousand fathoms at the most westerly station, where the temperature of the atmosphere at night was only a little above the freezing-point, though no ice was to be seen, we steamed back to the west side of the island. In the forenoon of August the 3rd, when bearing down on Mary Muss Bay, the weather was exceedingly foggy. We steered thence in a south-westerly direction along the coast, carefully watching for an opportunity to land, — but in vain. The fog frequently shut out the land; and a line of breakers was everywhere observed along the shore, the swell being no less heavy than on the occasion of our unsuccessfull attempt to land on the east side of the island. We stopped twice and sounded (see Map) in 98 and 156 fathoms. At these stations and several other points we succeeded in sketching the scenery of the low-lying tract in the southern part of Jan Mayen. Fig. 6 is from these sketches. Near the shore we see the parasitic crater Hoyberg; and farther inland, in the vicinity of Guinea Bay, a conical crater, — the "hay-cock," — small but regular in form, rises from the low-lying tract around it. The Low South Point projects in a line with the point of view. Behind the low tract in the foreground of the engraving, towers with its precipitous walls the plateau of the southern part of Jan Mayen. Here may be seen a conical-shaped mount (the Vøringen crater), in all probability of

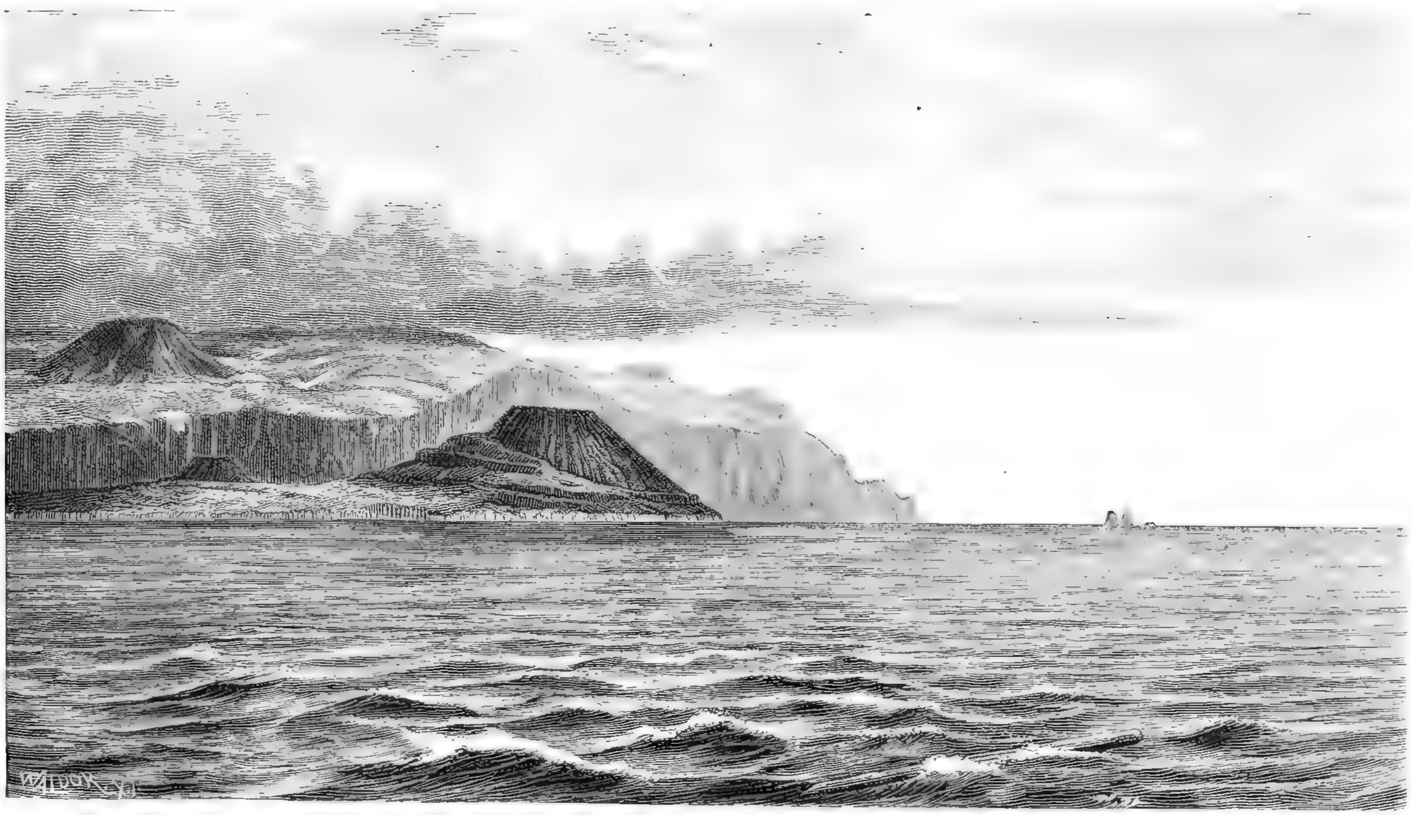


Fig. 6. Hoyberg.

Det var det sidste, vi saa af Jan Mayen. Taagen indhyllede atter alt. Vi fik Intet at se af Sydkysten eller Sydostkysten, idet vi styrede videre sydvestover.

Billedet, Fig. 7, der viser Jan Mayen i Vinterdragt, seet fra Nordvest, skyldes en Tegning af Lieutenant i den norske Marine S. Ring, der som Fører af Sælfangeren "Capella" har havt Anledning til at se Jan Mayen klar fra denne Kant. Man ser paa Skraaningen ned mod Nordostkap Krater Sars, man øjner de store Isbræer paa Nordsiden, Cap Nordvest og Muyens Korsnes vende mod Tilskueren, den lave Del af Øen paa Midten og Sydlandets Højder træde klart frem. Beerenbergs Krater viser sig med indsunket Rand paa Nordsiden, og derunder en vid Dal eller Kjedel, hvorfra de store Nordbræer tage sit Udspring.

eruptive origin. The precipitous declivities facing the sea extend to Cape South-West. Here there is a "gate," or natural excavation, in the mountain-wall, through which the sea passes. Off the promontory rise the Seven Rocks, with their rugged, fantastic contours.

This was the last we saw of Jan Mayen. The fog had again begun to thicken, and soon shrouded everything from view. Nothing could be seen of either the south or the south-east coast as we steamed ahead on a south-westerly course.

For the prospect (Fig. 7) of Jan Mayen in its winter garb, as seen from the north-west, we are indebted to a drawing from the pencil of Lieutenant S. Ring, R. N., who, when commanding the sealer "Capella," sketched this part of the island on a clear day. We have Sars's crater, on the slope shelving towards Cape North-East; we see, too, the great glaciers on the north side, also Cape North-West and Muyen's Cross Cape, in a line with the point of view; and the low tract of the island, with the heights of the southern part, are boldly defined in the picture. The crater of Beerenberg, with its sunken edge on the north side, is also seen, and lower down a huge, cauldron-shaped depression, from which the great northern glaciers take their origin.

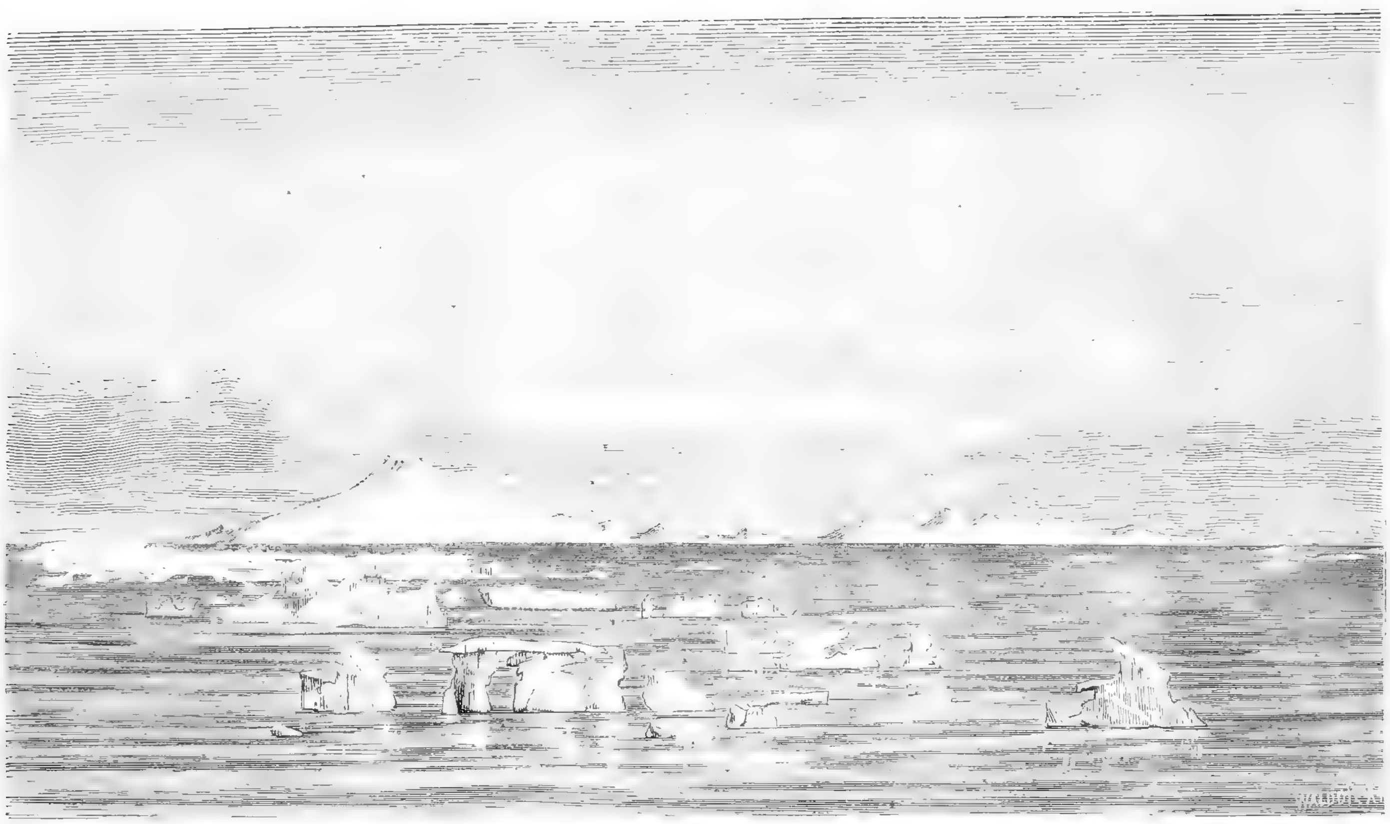


Fig. 7. Jan Mayen i Vinterdragt, fra Nordvest. — Winter View of Jan Mayen, looking South-East.

Af den foranstaaende Rejsebeskrivelse vil man se, hvorledes vor Expedition samlede det Materiale, vi have benyttet til at forbedre Kartet over Jan Mayen. Da Expeditionens Hovedformaal var at undersøge Havet, kunde vi anvende kun en kortere Tid til Undersøgelsen af Jan Mayen, og de Iagttagelser, som vi hertil kunde samle, maatte blive udførte lejlighedsvis, eftersom Omstændighederne tillod det. Vi kunde saaledes ikke afvente de gunstigere Omstændigheder, der vare nødvendige for en mere gjennemført Undersøgelse, men vare nødte til at combinere de erholdte Observationer og deres Resultater paa bedste Maade indbyrdes og med ældre Undersøgelsers Resultater. Dette har kostet ikke lidet Arbejde, og det af Captein Wille og mig udarbejdede Kart er Frugten af en Række gjentagne Forsøg paa at tilfredsstille alle de spredte Iagttagelser, der foreligge. Som man vil se, vare vi under vort Ophold ved Jan Mayen ikke særdeles begunstigede af Vejret, men vi vare heller ikke særdeles uheldige, dog var der liden eller ingen Lejlighed til at anstille *systematiske* Iagttagelser.

Af ældre Literatur vedrørende Jan Mayen er til Kartet og Beskrivelsen benyttet følgende:

1. De Nieuwe Groote Zee-spiegel, inhoudende Eene Beschryvinghe der Zee-Kusten van de oostersche en noordsche Schip-vaert. Amsterdam 1662. Beskrivelsen af Jan

The foregoing account of our exploratory work will show in what manner data were collected on the Norwegian Expedition for constructing a new map of Jan Mayen. The main object of the Expedition being to investigate the physical conditions of the sea, the time we could devote to the exploration of Jan Mayen was of course comparatively short; and the observations we succeeded in obtaining had to be taken occasionally, according as opportunity offered. Thus it was not in our power to carry out a complete investigation; we could only combine in the best possible manner our observations and their results, collating them with those of earlier explorers. To do this has cost considerable labour, and the Map constructed by Captain Wille and myself is based on a series of re-iterated attempts to combine all the scattered data before us. As previously shown, the weather during our stay at Jan Mayen was neither particularly favourable nor exceptionally bad; but we had little or no opportunity of instituting *systematic* observations.

Of earlier works on Jan Mayen, the following have been consulted:

1. — De Nieuwe Groote Zee-spiegel, inhoudende Eene Beschryvinghe der Zee-Kusten van de oostersche en noordsche Schip-vaert. Amsterdam 1662. To this account is

Mayen ledsages af et "Pas-caert van Jan Mayen Eylant". I den benyttede Udgave mangler desværre et Blad, paa hvilket Beskrivelsen af Øens Nordside skulde være at finde. En noget forkortet Oversættelse af denne Beskrivelse til Tysk, som Professor Buijs Ballot i Utrecht har havt den Godhed at sende mig, slutter imidlertid med den Bemerkning, at Beskrivelsen af Nordsiden mangler. Forøvrigt beskrives i dette gamle Verk Ostkysten helt fra Nordostkap sydover og Vestkysten fra Sydkap nordover indtil Nordvestkap. Kartet, der aabenbart er det som ligger til Grund for alle de senere Karter over Jan Mayen, forekommer mig i sine Hovedtræk at være lige saa godt som disse.

2. C. G. Zorgdragers alte und neue Grönlandische Fischerei und Wallfischfang, . . . ausgefertiget durch Abraham Moubach. Leipzig 1723. For Jan Mayens Vedkommende har jeg i dette Verk ikke fundet noget mere end i det foregaaende, der aabenbart er Kilden.

3. An Account of the Arctic Regions. . . . by W. Scoresby Jun. F. R. S. E. Edinburgh 1820. Til Grund for Scoresby's Kart ligger Zorgdragers, der aabenbart igjen har til Kilde det gamle Kart i "Zee-spiegel". Hele Øens Beliggenhed er rectificeret af Scoresby, men i Detaljerne er det gamle Kart fremdeles det paalideligste.

4. Letters from High Latitudes, being some account of a voyage, in 1856, in the schooner-yacht "Foam," to Iceland, Jan Mayen, & Spitzbergen. By Lord Dufferin. Fourth Edition. London 1858.

5. Nord-Fahrt, entlang der Norwegischen Küste, nach dem Nordkap, den Inseln Jan Mayen und Island, . . . unternommen während der Monate Mai bis Oktober 1861 von Dr. Georg Berna. . . . Erzählt von Carl Vogt. Frankfurt a. M. 1863.

Det Kart, som ledsager Vogt's Beskrivelse, er en Copi af Scoresby's Kart. Det indeholder en Del Forbedringer, men er paa den anden Side, navnlig i hydrografisk Henseende, mindre fuldstændigt og correct end de ældre Karter. Derimod have de Billeder af Partier af Jan Mayen, der ledsage Vogt's Verk, været mig af overordentlig stor Nytte, og for deres store Paalidelighed kan jeg indestaa. Endog mindre Træk i Landskabet har jeg efter disse Billeder kunnet identificere.

Til Grund for Constructionen af vort Kart er lagt Scoresby's. Efter de af os foretagne Pejlinger og andre Vinkelmaalinger har Capt. Wille gjort et Udkast til Kystens Form, og anbragt derved de hydrografiske Detaljer fra vore Iagttagelser, saa langt de rak, og fra Scoresby. Efter det Material, som stod til min Raadighed, heri indbefattet en Række Skitser af Hr. Schiertz, vor Tegner, Professor Sars og mig selv, har jeg forsøgt at aflægge yderlige hydrografiske Detaljer, dels efter "Zeespiegel", idet jeg fandt, at Beskrivelsen og Kartet i dette var rigtigere end i de senere Verker, dels ved Hjelp af Skitserne, efter hvilke jeg kunde bestemme noget sikrere enkelte Partiers indbyrdes Beliggenhed, navnlig i Forbindelse med de verticale Dimensioner. Situationen

annexed a "Pas-caert van Jan Mayen Eylant." In the edition I have consulted, the leaf on which an account of the north coast of the island might have been looked for, is unfortunately missing. A somewhat abridged translation of this work into German, which Professor Buijs Ballot of Utrecht had the kindness to send me, closes, however, with the remark, that no account has been given of the north side. For the rest, in this old volume the east coast is described from Cape North-East southwards, and the west coast, from Cape South northwards to Cape North-West. The map, which is manifestly that on which all later maps of Jan Mayen are based, would appear in its main features to be quite as correct as any of these.

2. — C. G. Zorgdragers alte und neue Grönlandische Fischerei und Wallfischfang, . . . ausgefertiget durch Abraham Moubach. Leipzig 1723. As regards Jan Mayen, I found nothing in this work that is not contained in the foregoing, whence the author has evidently drawn his information.

3. — An Account of the Arctic Regions . . . by W. Scoresby Jun. F. R. S. E. Edinburgh 1820. Scoresby's map is based on Zorgdrager's, which in turn is evidently derived from the old map in the "Zee-spiegel." The position of the island has, indeed, been rectified by Scoresby; but in all details the old map is still the most trustworthy.

4. — Letters from High Latitudes, being some account of a voyage, in 1856, in the schooner-yacht "Foam," to Iceland, Jan Mayen, & Spitzbergen. By Lord Dufferin. Fourth Edition. London 1858.

5. — Nord-Fahrt, entlang der Norwegischen Küste, nach dem Nordcap, den Inseln Jan Mayen und Island, . . . unternommen während der Monate Mai bis Oktober 1861 von Dr. Georg Berna. . . . Erzählt von Carl Vogt. Frankfurt a. M. 1863.

The map annexed to Vogt's account of the Island is a copy of Scoresby's. It is, indeed, in some respects more correct, but in others, more particularly as regards the hydrographical details, less complete and trustworthy than the earlier maps. On the other hand, the views of the Island accompanying Vogt's work have rendered me the greatest service; and for their accuracy, which is remarkable, I can personally vouch. Even minor features of the scenery, I have been able to identify from these excellent illustrations.

Our map of Jan Mayen is based on Scoresby's. From the various bearings and other measured angles, Captain Wille has figured the contours of the coast, and set down, so far as possible, the hydrographical details, from our own observations and those of Scoresby. After a careful study of the material collected, including numerous sketches by Mr. Schiertz, artist to the Expedition, Professor Sars, and myself, I have sought to fill in further hydrographical details, partly since I find the account and map in the "Zeespiegel" to be more correct than are any of those given in later works on Jan Mayen, and partly with a view to determine, by means of the sketches, with greater accuracy the relative position of divers parts of

paa Kartet, der er fremstillet ved Højdekurver for hver 100 Meter, beror paa vort fælles Arbejde, saaledes at de store Træk ere udkastede af Capt. Wille, medens jeg har nærmere udarbejdet Detaljen. Herved er stadig taget Hensyn til, at Skitserne gjerne, som ogsaa de udførte Vinkelmaalinger vise, overdrive de verticale i Forhold til de horizontale Dimensioner. Efter mange gjentagne Forsøg er det i det Hele taget lykkets mig at tilvejebringe en god Overensstemmelse mellem Skitserne og de tagne Vinkelmaal.

Øens geografiske Beliggenhed er aflagt efter vore astronomiske og geodetiske Observationer.[1]

Ved Sammenligning mellem de ældre Karter og vort vil man finde adskillige Afvigelser. Jeg skal her vise de vigtigste af disse.

Scoresby's Bredder stemme gjennemgaaende godt med vore. Efter Udmaaling af 19 Punkter finder jeg, at Scoresbys Bredder i Gjennemsnit er et halvt Minut større end vore, og den største Forskjel er 2 Minutter. Scoresby's Længder ere derimod gjennemsnitlig 28 Bueminuter mindre end vore. Afvigelserne variere mellem 20 og 33 Minuter. Med andre Ord, Jan Mayen ligger efter vor Bestemmelse lidt over 9 Kvartmil længere Vest end i Scoresby's Kart og i de hidtil brugte Søkarter. Da vor Længdebestemmelse ikke er usikker paa mere end nogle faa Tidssekunder, bliver Jan Mayens geografiske Beliggenhed at rette i Karterne. Ogsaa den hollandske Expedition med Skonnerten „Willem Barendsz" i 1878 fandt Jan Mayens vestlige Længde større end Karterne angive. Scoresby's Bestemmelse er fra August 1817; han havde da været i Søen fra Vaaren af, og det er ikke at undres over, at hans Chronometers beregnede Stand kunde afvige betydeligt fra den rigtige.

„Zeespiegel" lægger Jan Mayen mellem Bredderne 71° 0′ og 71° 30′, altsaa en 15 Minuter for langt mod Nord, og Øens Midte paa Meridianen af Cap Landsend, eller 5° 40′ Vest for Greenwich, det er næsten 3 Grader for langt mod Øst.

Den nordlige Del af Øen og den midterste lave Del stemme i sine større Omrids vel overens paa alle Karter. Den sydlige Del derimod have vi fundet kortere og bredere end paa de ældre Karter, et Resultat, der fremgaar saavel af vore Vinkelmaalinger som af de, med Loggemaskinen bestemte, udsejlede Distancer.

Efter alle vore Vinkelmaalinger, saavel horizontale som verticale, og efter alle Skitser ligger Beerenbergs Kegle og Krater mere centralt paa Nordlandet end hos Scoresby og Vogt. Vi fandt Højden af Beerenberg den 3die August at være 1945 Meter, medens Scoresby angiver den til 6870

[1] Se H. Mohn. Astronomiske Observationer Side 23.

the island, in particular as regards their vertical extent. The relief of the land — shown on the Map by contour lines for every 100 metres, — is the result of our joint labours, Capt. Wille having laid down the general features while I worked out the details. Regard has been everywhere had to the tendency exhibited in the sketches, as confirmed too by the trigonometrical measurements, of increasing the vertical and lessening the horizontal extent. After numerous re-iterated attempts I at length succeeded in attaining satisfactory agreement between the sketches and the trigonometrical measurements.

The geographical position of the island is that found from our astronomical and geodetical observations.[1]

On comparing the earlier maps of Jan Mayen with that we have now constructed, ours will be found to differ in many respects. I will point out the most important.

Scoresby's latitudes agree on the whole satisfactorily with those determined by ourselves. By direct measurement of 19 points, I found Scoresby's latitudes on an average to exceed ours by half a minute; the greatest difference is 2 minutes. Scoresby's longitudes, however, are on an average 28 minutes of arc less than ours. The difference varies between 20 and 33 minutes. In short, Jan Mayen, according to our determination, lies a little more than 9 miles farther west than it does on Scoresby's map and the charts in use up to the present time. As the error of our determination of longitude does not amount to more than a few seconds in time, the geographical position of Jan Mayen on maps and charts will henceforth have to be rectified. The Dutch Expedition, too, despatched in 1878 with the schooner "Willem Barendsz," found the west longitude of Jan Mayen to be greater than that given in the charts. Scoresby's determination dates from August 1817. As captain of a whaler, Scoresby had then been at sea since the spring of the year; and hence it is not surprising that the true error of his chronometer should have deviated considerably from that computed.

The "Zeespiegel" places Jan Mayen between the parallels 71° 0′ and 71° 30′, thus 15 minutes too far north, and the middle of the island on the meridian of Land's End, or 5° 40′ west of Greenwich — nearly 3 degrees too far east.

The northern part of the island and the low-lying central tract agree well in their general contours on all the maps. The southern part, on the other hand, we found to be shorter and broader than it is given on the earlier maps, a result derived alike from our trigonometrical observations and the extent of the coast as determined by the water-log.

According to all our trigonometrical measurements, both horizontal and vertical, as also the numerous sketches, the cone and crater of Mount Beerenberg should have a more central position in the northern part of the island than has been given them by Scoresby and Vogt. We found

[1] H. Mohn. Astronomical Observations, p. 23.

engelske Fod eller 2094 Meter. De Højdemaalinger, som jeg fik fra Ankerpladsen i Mary Muss Bugten og fra Loddestationen No. 224 paa Østsiden (Side 12) stemme meget vel med en Højde af 1945 Meter, idet de give, Distantserne tagne efter Kartet, respective 1968 og 1944 Meter.

Paa alle de ældre Karter findes paa Vestsiden af Beerenberg, ved Havet, mellem første og andet Korsnes, et Sted betegnet som en Isbræ. Det hedder i "Zeespiegel": *Heynste Ysbergh*, hos Scoresby: *Iceberg*, og hos Vogt er vist en fra Beerenbergs Side til Havet udgaaende stor Isbræ. Da vi besøgte Jan Mayen, fandtes her paa denne Kant ingen Isbræ, der gaar til Havet. Vi saa kun enkelte Snefiækker paa den lavere Del af Øen. Scoresby og Vogt, der begge kun saa Jan Mayens Østkyst, have aabenbart hentet denne Bræ fra det gamle hollandske Kart. Er Bræen forsvunden siden Begyndelsen af det 18de Aarhundrede? Zorgdrager har den, og den staar nævnt i Beskrivelsen i "Zeespiegel". Eller foreligger en Forvexling med Bræerne paa Nordsiden?

De 3 store Isbræer paa Nordsiden af Jan Mayen findes ikke angivne paa Kartet i "Zeespiegel", og heller ikke hos Zorgdrager, Scoresby eller Vogt. Nordsiden er, som tidligere nævnt, ikke beskrevet i "Zeespiegel", men paa Zorgdragers Kart findes angivet Trankogerier i østre Korsbugt, saa at man maa antage, at denne Kyst i tidligere Tider var vel kjendt. Have disse Bræer først siden Midten af forrige Aarhundrede naaet den nuværende Udstrækning?

Paa Østsiden af Beerenberg saa vi fem store Isbræer, der med en brat Heldning gik lige ned til Havet. Flere end dette Antal kunde med Bestemthed ikke anføres. "Zeespiegel" har saavel i Kartet som i Beskrivelsen kun 3 Isbræer her, i Beliggenhed svarende til de tre nordligste, ligesaa Zorgdragers og Scoresby's Kart, hvilket sidste dog grupperer dem noget anderledes, idet de to sydligste ere lagte paa noget nær samme Plads, som vore to sydligste. Scoresby's Billede derimod viser flere end 5 til Havet nedrækkende Bræer paa denne Kyst, hvilke det er vanskeligt at identificere med de af os sete. Paa Kartet i Berna's "Nordfahrt" kan jeg ikke gjenfinde vore fem Bræer, men vel paa Billedet af Østkysten i samme Verk. Ere de stejle Isbræer paa Østkysten med Hensyn til Antal og Betydenhed vexlende med Tiderne?

Sydbræen findes ikke paa Karterne i "Zeespiegel", hos Zorgdrager og Scoresby, omtales heller ikke i disses Beskrivelser. Den forekommer først hos Vogt, hvis Kart, Billeder og Beskrivelse stemme godt med vore Iagttagelser. Kysten udenfor er, efter de ældre Beskrivelser, meget uren, saa at Bræen maaske ikke havde nogen hydrografisk Inter-

the altitude of Beerenberg — August the 3rd — to be 6380 feet, whereas Scoresby's determination is 6870 feet. The altitudes I succeeded in taking from our anchorage in Mary Muss Bay and from Sounding-station 224, on the east side of the island (page 12), agree very well with a height of 6380 feet, corresponding as they do to 6457 and 6377 feet.

On the west side of Beerenberg, in close proximity to the sea, between the first and second Cross Capes, there is in all of the earlier maps a point marked to denote a glacier. In the "Zeespiegel" it bears the name of *Heynste Ysbergh*; Scoresby calls it *Iceberg*; and in the map accompanying Vogt's work on Jan Mayen a large glacier is here seen extending down the slope of the mountain to the sea. When *we* visited the island, there was no glacier reaching out to the sea on this side. We merely saw a few patches of snow scattered here and there over the lower tract of the coast. Scoresby and Vogt, both of whom saw only the eastern shores of Jan Mayen, have manifestly followed the old Dutch map. Can the glacier have disappeared since the beginning of the 18th century? Zorgdrager has it, and it is mentioned in the account given in the "Zeespiegel." Or has there been some mistake connected with the glaciers of the north side?

The 3 great glaciers on the north coast of Jan Mayen are not to be found on the map in the "Zeespiegel," nor on those by Zorgdrager, Scoresby, or Vogt. As previously mentioned, no account is given of the north side in the old Dutch work; but on Zorgdrager's map we have given the position of factories established in East Cross Bay for boiling down blubber; and hence that coast must have been well known in former times. Possibly, the glaciers in question did not attain their present extent till the middle of the last century.

On the east side of Beerenberg, we saw 5 large glaciers shelving abruptly down to the sea. A greater number could not be clearly distinguished. Only 3 glaciers are to be found here on the map in the "Zeespiegel," corresponding in position to the three northernmost of ours, as also on the maps by Zorgdrager and Scoresby, though the latter groups them somewhat differently, the two lying farthest south having almost the same position as the two most southerly of those observed by ourselves; but on the other hand, in Scoresby's view of the coast more than 5 glaciers, which can hardly be identified with those we observed, extend down to the sea. On the map in Berna's "Nordfahrt" I cannot find our 5 glaciers; in his view of the east coast, however, in the same work, they are easy to identify. Do the precipitous glaciers on the east coast, as regards number and extent, possibly undergo some change in the course of centuries?

The Southern Glacier is not to be found on any of the earlier maps of Jan Mayen, nor is it mentioned in the accounts of the island given in the "Zeespiegel" and by Zorgdrager and Scoresby. The first to call attention to this glacier was Vogt, whose map, views, and general account of the island closely agree with our own observations.

esse for de gamle Hvalfangere i det 17de Aarhundrede, men paafaldende er det unegtelig, at Scoresby, der roede langs denne Kyst den 4de August 1817 og var iland paa Toppen af Krater Esk samme Dag, ikke omtaler denne betydelige Bræ, der danner et saa fremtrædende Træk i Landskabet. Se Vogt's Beretning og vort Billede. Er ogsaa den en nyere Tids Dannelse?

Med Hensyn til Krater Esk og Krater Vogt maa jeg bemerke, at jeg efter nøjagtig Gjennemgaaen af Scoresby's og Vogt's Beretninger er kommen til det bestemte Resultat, at disse Forskere have besteget forskjellige Kratere. Vogt beretter nemlig, at han besteg Scoresby's Krater Esk. De ældre Karter give ingen Vejledning, da disse Gjenstande ikke ere af nogen hydrografisk Interesse. Scoresby siger (I, Side 162), "at han fra Krater Esk saa ved Foden af Bjerget paa Sydostsiden, i Nærheden af en vældig Lavastrækning, et andet Krater med Rand som en Murtinde, af lignende Form som det ovenfor beskrevne (Esk)." Begge Kratere ere angivne paa hans Kart, det vestligste betegnet "Esk Mount, a Volcano". Vogt saa fra det Krater, han besteg, nede paa det lave Forland det lave Askekrater "Berna", der neppe hæver sig over Sletten, og paa Vogt's Kart er Scoresby's andet Krater udeladt og "Berna" sat istedet. Efter hvad jeg, som ovenfor nævnt, til forskjellige Tider kunde se, findes alle 3 Kratere, saaledes som paa vort Kart angivet. Der er i Vogt's Beskrivelse, saavidt jeg kan se, Intet i Vejen for at antage, at det Krater, Scoresby saa tydelig fra Toppen af "Esk", er det, som Vogt har besteget. Jeg har ogsaa tilladt mig at give dette Krater Navn efter denne Forsker, hvis Rejse til Jan Mayen i saa høj Grad har udvidet vor Kundskab om denne Ø, og hvis Beskrivelse deraf havde orienteret mig i Forvejen i den Grad, at jeg under vort Besøg der havde en Følelse, som om det var en tidligere kjendt Egn, jeg var kommet til.

Ægøen er i "Zeespiegel", hos Zorgdrager og hos Scoresby fremstillet som en fra Hovedlandet ved et Sund adskilt virkelig Ø. Vogt's Kart forbinder den med Land ved en ganske smal Tange. Vi saa den som en fuldstændig Halvø. Man se Fig. 2 og Kartet. Scoresby's Cape Brodrick, Pynten indenfor Sundet, er saaledes forsvundet mellem 1817 og 1861, idet Øen er bleven forbundet med Land. Landtangen, der nu er lige saa bred som Ægøen selv, ligger adskillige Meter over Havspejlet.

Lagunen paa Vestsiden omtales i "Zeespiegel" og forekommer paa Kartet saavel her som i Zorgdrager's og i Scoresby's Verker. Paa Vogt's Kart er den bleven udeglemt. Den korte Beskrivelse i "Zeespiegel" stemmer godt med mine Iagttagelser paa Stedet. Den lange Lagune paa Østsiden derimod findes ikke i nogen af de ældre Beskri-

Off the coast, the navigation is here, according to the earlier accounts, a good deal incumbered with rocks and shoals; and hence, possibly, the old whalers of the 17th century did not attach any hydrographical importance to the glacier. It is however undeniably strange, that Scoresby, who on the 4th of August rowed along this part of the coast, and the same day ascended to the summit of Mount Esk, should not have mentioned so considerable a glacier, forming as it does a prominent feature of the scenery (see Vogt's account and our view). Can this, too, be a later formation?

As regards the Esk crater and the Vogt crater, I feel convinced, from a careful perusal of Scoresby's and Vogt's accounts, that the said explorers must have ascended different craters. According to Vogt's statement, he ascended the Esk crater (Scoresby's). The earlier maps afford no assistance in deciding this doubtful point, since such details, being without hydrographical interest for the navigators of that time, were not laid down. Scoresby, who had ascended the Esk crater, states (page 162), that "at the foot of the mount, on the south-east side, near a stupendous accumulation of lava, bearing the castellated form, was another crater, of similar form to the one above described." Both craters are to be found on his map, the most westerly of the two being designated "Esk Mount, a Volcano." Looking down from the crater he had ascended, Vogt saw beneath him, on the low-lying foreland, the low Berna crater, which hardly rises above the surrounding tract; and on Vogt's map Scoresby's second crater has been left out and the Berna crater substituted in its place. As previously stated, according to what I observed at different times, all 3 craters are to be found, in the respective positions given them on our map. In Vogt's account there is nothing, so far as I can judge, to oppose our assuming that the cone which Scoresby distinctly observed from the summit of Mount Esk is that ascended by Vogt. I have likewise made free to give this crater the name of the explorer whose voyage to Jan Mayen has so largely contributed to extend our knowledge of that interesting island, and whose accurate account had rendered me so familiar with its topography, that during our sojourn there I had frequently the impression of being in a country I had visited before.

Both in the "Zeespiegel" and in the maps by Zorgdrager and Scoresby, Egg Island is represented as a veritable island, cut off by a sound from the main land. On Vogt's map, an exceedingly narrow strip of land connects, it with the main island. As *we* beheld "Egg Island," it was in every respect a peninsula; see Fig. 2 and the Map. Scoresby's Cape Brodrick, the point lying within the sound, must accordingly have disappeared some time between the years 1817 and 1861. The isthmus, which is now equal in breadth to Egg Island itself, rises a score or so of feet above the sea-level.

The lagoon on the west side is mentioned in the account of the island given in the "Zeespiegel," and may be found on the map accompanying that work, as also on the maps by Zorgdrager and Scoresby. On Vogt's map it has been left out. The brief description in the "Zeespiegel" agrees closely with my own observations. On the other

velser eller Karter. "Zeespiegel" har paa dette Sted to lange Bugter, Store og lille Rækved-Bugt ("Groote Hout bay" og "Cleyne Hout bay"), adskilte ved en til Havet gaaende Bergmasse. Denne er aabenbart den samme som vi kaldte "Stotten", og som sees saavel paa vort Billede af Lagunen som paa det tilsvarende Billede Side 282 hos Vogt. I Bugten har "Zeespiegel" en flad Fjære af Sand, dækket med Rækved, og i Havet udenfor er der temmelig grundt, 6, 7 og 8 Favne indtil $1^1/_2$ Kvartmil fra Stranden. Zorgdrager og Scoresby har det samme. Scoresby fortæller, at, da han var paa Toppen af "Esk", "var, mod Sydvest, hele Øens Udstrækning synlig", men nævner ikke et Ord om Lagunen, og har den heller ikke paa sit Kart. Fra Toppen af sit Krater beretter Vogt, at han saa Lagunen i hele dens Udstrækning, og fra "Esk" skulde den være lige saa godt synlig. Man tør herefter med Vogt trygt slutte, at Lagunen er dannet mellem begge Forskeres Besøg, mellem 1817 og 1861. Jeg tror snarere, at den er dannet ved at den lave Sandvold, som adskiller den fra Havet, efterhaanden er opkastet af Brændingen, end, som Vogt antager, at Lagunens Flade tidligere var dækket af "Bankisen". Ægoens Forbindelse med Land staar aabenbart i nøjeste Forbindelse med Lagunvoldens Fremkomst over Havspejlet; thi Ægøens Landtunge udgjør den directe Fortsættelse af Lagunvolden. En Hævning af Landet her er ikke utænkelig, men paa den anden Side af Øen, ved den vestre Lagunes Vold, er der, naar "Zeespiegel"s Beskrivelse fra Midten af det 16de Aarhundrede sammenholdes med mine ovenfor nævnte Iagttagelser, ikke noget Tegn til nogen merkelig Hævning. Paa vor Kundskabs nærværende Standpunkt kunne Gjætninger lige saa lidet hjelpe os her som ved Spørgsmaal om Jan Mayens Isbræers Forandringer.

De af Havet opragende Klipper "Lodsbaaden" og "Fyrtaarnet" ligge efter vore Maalinger og Tegninger som paa vort Kart angivet. De findes begge omtalte i "Zeespiegel" og afsatte paa Kartet deri som "Klip als een Seyl". Deres Beliggenhed er rigtigere paa det gamle hollandske Kart end hos Scoresby, der lægger "Lodsbaaden" for langt mod Syd og "Fyrtaarnet" for langt fra Land.

Guinea-Bugtens nordligste Pynt stikker, ifølge vore Skitser, mere frem end paa Scoresby's Kart. Heri stemme vi bedre overens med "Zeespiegel".

Vogel-klip ligger ifølge "Zeespiegel" lige udenfor Vestpynten af Syd-Bay, ikke som hos Scoresby i Sydvest for denne. "Naar man ligger paa 15 Favne Vand i Syd-

hand, the long lagoon on the east side is not mentioned in the earlier accounts of Jan Mayen, nor does it appear on any of the annexed maps. In the "Zeespiegel," this part of the coast exhibits two long bights, — Great Wood Bay and Little Wood Bay ("Groote Hout bay" and "Cleyne Hout bay"), disconnected by a rocky mass stretching between them down to the sea. It is evidently this cliff to which we have given the name of "Søjlen" (the pillar), and which appears both in *our* view of the lagoon and in that given on page 282 of Vogt's work. In the "Zeespiegel," the bay has a flat sandy beach covered with driftwood, and the water is shallow — 6, 7, and 8 fathoms — to the distance of a mile and a half from the shore. The same details are given in the maps by Zorgdrager and Scoresby. Scoresby states, that from the summit of Mount Esk, "towards the south-west the utmost extent of the island was visible;" but he does not say a word about the lagoon, nor is that prominent feature of the coast to be found in his map. From the top of the crater bearing his name, Vogt could overlook the lagoon in its full extent, and the same should be the case from the summit of Mount Esk. Hence, it would be reasonable to infer with Vogt, that the lagoon has been formed between the visits of the two explorers, or some time during the interval extending from 1817 to 1861. Meanwhile, the origin of the lagoon must, I think, be ascribed to the low sand-barrier stretching between it and the sea having been gradually thrown up by the action of the surf, rather than, as Vogt surmises, to the possible fact of its surface having in former times been covered with "bank-ice." The conversion of Egg Island to a peninsula is beyond doubt closely connected with the appearance of the lagoon barrier above the sea-level, since the Egg Island isthmus constitutes the direct continuation of the said barrier. True, there may have been a rise along this part of the coast; but on the other side of the island, if the account given in the "Zeespiegel" from the middle of the 16th century be compared with the results of my own observations, there can hardly have been a perceptible rise at the barrier of the western lagoon. At the present stage of research, hypothetical deductions are as futile here as in questions bearing on a presumptive change in the number and position of Jan Mayen's glaciers.

The two rocks rising abruptly from the sea called respectively the "pilot-boat" and the "light-house," have, according to our observations and drawings, the position given them in the annexed Map. They are both mentioned in the "Zeespiegel," and laid down on the map accompanying that work as "Klip als een Seyl." The old Dutch geographer has placed these rocks more correctly than Scoresby, on whose map the "pilot-boat" lies too far south and the "light-house" too far from the shore.

The most northerly point of Guinea Bay projects, according to our drawings, farther out than it does on Scoresby's map. In this detail we agree better with the "Zeespiegel."

Vogel-klip lies according to the "Zeespiegel" just without the west point of South Bay, not as on Scoresby's map to the south-west of that bight. "When anchored in

Bay', saa ser man ud mellem Vogel-klip og Landet."

Et Stykke fra Hoepstock's Bay "finder man et Nes, tvers af hvilket der ligger nogle Klipper, som kaldes *de Rudsen*"[1] ("Zeespiegel").

"Walrusch Gat" kaldes Kloften udenfor det Nes, som skyder ud paa Nordsiden af English Bay, og udenfor hvilket det "Brielske Taarn" staar. Se Fig. 3.

Strax vestenfor Mary Muss Bugt staar paa "Zeespiegel"s og Zorgdragers Kart en af Havet opragende Klippe. Nogen saadan saa vi ikke, men vel et Skjær, over hvilket Søen brød. Klippen er styrtet i Havet.

Paa Kartet i "Zeespiegel" stikker Fugleberget frem som et langt Nes mod Nord. I Beskrivelsen hedder det: "Fra Østpynten af Mary Muss Bay skyder en Bergfod fra Landet ud i Søen, meget stejl og høj ved sin Vest-Strand. Nu er der intet saadant udskydende Nes. Men der ligger en Boe udenfor Fugleberget.

Af Sidekratere paa Jan Mayen have vi observeret flere end der er aflagt i de ældre Karter. Jeg henviser til Rejsebeskrivelsen ovenfor og Kartet samt Billederne. De paa Kartet som Kratere betegnede Fjeldtoppe, der ikke ere omtalte i Rejsebeskrivelsen, ere aflagte efter Tegningerne og ere antagne, paa Grund af deres Form, der er eller nærmer sig den koniske, for at svare til dette Navn.

Adskilt ved dybe Have fra alle nærmeste Lande ligger Jan Mayen ensom ude i Grønlandshavet. Mellem Norge og Jan Mayen er Havet 1760 Favne dybt, mod Spidsbergen over 2000 Favne, mod Grønland over 1300 Favne og mod Island over 1000 Favne dybt. Øens Retning er fra NE. t E.—SW. t W., den peger mod Danmarkstrædet og ligger parallel Heklas Vulkanlinie. Den er efter alt hvad derom er blevet observeret, bygget udelukkende af vulkanske Bergarter, og disse synes alle at tilhøre den moderne Vulkanisme. Den er saaledes yngre end Færøerne og Island, hvor ældre vulkanske Bergarter ere eneraadende eller danne Grundvolden. Dens Længde er lidt over $7^1/_2$ geografisk Mil. Den dannes af to større Dele, den nordlige og den sydlige, der ere forenede ved en lavere og smalere Landstrækning. Den nordlige Dels største Bredde er lidt over 2 geografiske Mile, den sydliges $1^1/_2$ geografisk Mil, og paa det smaleste Sted er Bredden $1^1/_2$ Kvartmil

[1] Rudsen = Fr. roche = Klippe.

15 fathoms in South Bay, you look out between Vogel-klip and the land."

A short distance from Hoepstock's Bay "there is a noss, or promontory, off which are seen a few rocks, called *de Rudsen*"[1] ("Zeespiegel").

"Walrusch Gat" is the name given to the chasm lying without the promontory that juts forth on the north shore of English Bay, and beyond which rises "Brielle Tower" (see Fig. 3).

A little west of Mary Muss Bay, both on the map in the "Zeespiegel" and on that by Zorgdrager, there is a rock projecting abruptly out of the sea. We could discover no such rock; but we saw a shoal over which the sea was breaking. The rock in question must at some later period have toppled down into the sea.

On the map in the "Zeespiegel," the Fugleberg projects towards the north as a long noss, or headland, described in the account as follows: — "From the east point of Mary Muss Bay, the base of a mountain, very lofty and precipitous on its west side, juts out from the land into the sea." *Now* there is no such projecting promontory. A sunken rock, however, lies off the Fugleberg.

Of parasitic craters on Jan Mayen, we observed a greater number than are given in the earlier maps of the island. For further information on this head, the reader is referred to the above account of our exploratory work, as also to the Map and the illustrations. The mountain summits marked on the map as craters, though not mentioned in the account of the island, have been laid down from sketches, and are, by reason of their form, which is more or less conical, presumably entitled to the name.

Cut off on all sides by extensive ocean tracts from the nearest land, the Island of Jan Mayen occupies an isolated position in the Greenland Sea. Between Norway and Jan Mayen the depth reaches 1760 fathoms, towards Spitzbergen upwards of 2000 fathoms, towards Greenland upwards of 1300 fathoms, and towards Iceland upwards of 1000 fathoms. The direction of the island is from NE. by E. to SW. by W.; it points towards Denmark Strait, and lies parallel to the volcanic line of Mount Hecla. As previously stated, Jan Mayen is built up of volcanic rocks, all of which would appear to belong to the modern group. Hence the island is probably a later formation than are the Færoes and Iceland, where the old volcanic rocks prevail either exclusively or in greater part. Its length slightly exceeds $7^1/_2$ geographical miles. It consists of two large parts or divisions, a northern and a southern, connected together by a lower and narrower tract. The greatest

[1] Rudsen: Fr. roche: rock.

(0.4 geogr. Mil), Lagunen medregnet. Dens Fladeindhold er 7.32 geogr. Kvadratmil.

Den nordlige Del er den største og mest fremtrædende. I dens Midte troner det 1950 Meter høje Beerenberg, en udslukt Vulkan; Krateret har en Bredde af 1330 Meter. Den øverste Kegle har en ydre Skraaning af 42° og en Højde af omkring 600 Meter. Den synes, at dømme efter de sorte Flekker, der navnlig paa Vestsiden ere saa fremtrædende, at være dannet af Aske. Den Basis, hvorpaa denne Kegle hviler, skraaner til alle Kanter udad med en Heldning af 8 til 10 Grader, en Heldning der mod Nord og Øst fortsætter under Havet til mindst 1000 Fávnes Dyb. Kraterets Rand viser sig takket og den højeste Tinde ligger paa Vestsiden. Mod Nord er Kratervæggen tildels indstyrtet paa en Højde af et Par hundrede Meter. Den saaledes dannede Dalsænkning fortsætter nordover ned imod Nordsiden af Øen, begrændset paa begge Sider af divergerende Bergrygge, der tildels skyde sig frem terrassevis. Dette er Beerenbergs *val del bove*, der danner Firnmulden for dens største Isbræer, som skyde sig ud paa Nordsiden. Paa Østsiden findes ogsaa fremstaaende Ribber, der dele Østsidens Gletscherfelter, men mod Syd og Vest synes den øvre Kegles Yderflade at være meget jevn, kun oppe ved Kraterranden furet af smaa Indsænkninger mellem Kratertakkerne. Beerenbergs Basis gaar mod Vest, Sydvest og Nordost med temmelig jevne Skraaninger helt ned til Havet eller Lavlandet, men mod Nord og mod Øst danner den særdeles stejle Kyster, der frembyde Præcipicer paa 300 Meters Højde. Paa flere Steder er Basisen gjennemfuret af dybe Indskjæringer, gjennem hvilke Isbræerne finde sin Vej til Havet.

Sydlandets Højde naar ikke paa langt nær op til Nordlandets. Sydlandet danner et Højplateau, der mod Sydost og Syd har mange bratte Styrtninger mod Havet, men mod Nordvest har foran sig et lavt Forland, hvis Højde ikke rækker 100 Meter over Havet. Højden af Sydlandets Plateau anslaar jeg til omkring 300 Meter. Ovenpaa dette hæve sig nogle større Højder, af hvilke den højeste, der synes at frembyde en konisk Spids og saaledes muligens er en vulkansk Kegle, neppe rager over 500 Meter op over Havfladen.

Den lavere midterste Del af Øen, der er bygget af faste Lavamasser og rigelig besat med Eruptionskratere, naar paa sit laveste en omtrentlig Højde af kun 66 Meter eller maaske mindre, medens Kratertoppene naa op til

breadth of the northern part is a little more than 2 geographical miles, that of the southern $1^1/_2$ geographical miles, and the connecting tract (including the lagoon) measures at the narrowest point $1^1/_2$ English miles across (0.4 geographical mile). The area of the island is 7.32 geographical square miles.

The northern part of Jan Mayen is larger and more elevated than the southern. From its central tract towers the monarch of the island, Mount Beerenberg, an extinct volcano, rising in regal majesty to the height of 6400 feet. The crater measures 4360 feet in diameter. The upper cone, which shelves at an angle of 42° and attains an altitude of about 2000 feet, would, to judge from the black spots so conspicuous on its western declivity, appear to be composed of ashes. The base supporting the cone slopes out in every direction at an angle of from 8 to 10 degrees, and this incline is retained towards the north and east to a depth of at least 1000 fathoms beneath the sea-level. The edge of the crater has a jagged appearance, and the loftiest peak lies on the west side of the mountain. Towards the north, the wall of the crater has partially given way down to a height of from 600 to 700 feet. The depression thus formed extends northwards towards the north coast of the island, bounded on either side by diverging mountain ridges, that here and there project ledge-like one above the other. This is Beerenberg's *val del bove*, which constitutes the snow-field for the largest of its glaciers, that jut out from the north side of the mountain. On the east side, too, are seen prominent ribs, all of which intersect the nevés of the east side; towards the south and west, however, the surface of the outer cone would appear to be remarkably smooth, at the edge of the crater only being furrowed with shallow depressions between the jags. The base of Mount Beerenberg shelves towards the west, south-west, and north-east with a comparatively gentle incline, either to the water's edge or the low-lying shore; towards the north and east, however, the descent at the coast is very abrupt, exhibiting precipices 1000 feet high. In several places the base of the mountain is intersected by deep ravines, through which the glaciers find a passage to the sea.

The height of the southern part of the island cannot be compared to that of the northern. The southern land constitutes a wide plateau, which, in a south-easterly and southerly direction exhibits numerous precipices along the coast, but, towards the north-west, has extending before it a low-lying foreland, less than 300 feet above the sea. The height of the plateau I estimated at 1000 feet. Rising above this table-land are seen several summits; the loftiest, which has apparently a conical form, and may therefore be of eruptive origin, can hardly attain an altitude of 1600 feet above the sea-level.

The low middle tract of the island, which is built up of compact masses of lava and bears numerous eruptive craters, has at its lowest point an elevation of only 200 feet, or perhaps even less, whereas the crater summits

150 à 200 Meter. Fugleberget er maalt til 150 Meter, Ægøen anslaaet til c. 150 Meter.

Beerenbergs Basis er, som paavist af Carl Vogt, bygget af Lavalag og tildels Tuflag, der synes at have flydt eller være kastet ud af det store Central-Krater, sandsynligvis førend dette havde opbygget den øvre Askekegle. Af lignende Bygning er Øens Midtparti og efter Udseendet at dømme ogsaa den sydlige Del. Ovenpaa denne store sammenhængende Lavamasse staa en Mængde smaa Sidekratere, der for en stor Del have bevaret en udpræget konisk Form. Saadanne ere Krater Sars, Krateret øst for Sydbræen, Kraterne Esk og Vogt, Kraterne Danielssen og Blytt og Kraterne ved Guineabugten. Forstyrrede i sin Form ere Fugleberget paa Vestsiden og Ægøen paa Østsiden, idet begges ydre Kraterrand er opslugt af Havet. Nogle af Sidekraterne ere byggede af Lava og have udsendt betydelige Lavastrømme, som Vogt, Esk, nogles Top er bygget af løse udkastede Masser, Slakker og Aske, Rapilli, som Kraterne ved Mary Muss Bugten, ved Guineabugten, andre af Tuflag, Tufconglomerater og faste Lavalag, som Fugleberget, og atter andre af Aske alene, som Ægøen og Berna.

Den vulkanske Hovedspalte, hvorpaa Jan Mayen er bygget, gaar aabenbart efter Øens Længderetning, efter Heklalinien. Men Sidekraternes Gruppering synes at give en Antydning af, at der har været Tverspalter i Retningen WNW.—ESE. Vi have nemlig i denne Retning, som det synes, flere Rader af Sidekratere, saasom Esk—Vogt—Berna, Fugleberg—Egø, Hoyberg—Krater ved Fyrtaarnet (?). Er det et Tilfælde, at Endekrateret mod SE. i de to første Rækker, Berna og Ægø, kun have udkastet Aske?

Af Dale gives der paa Jan Mayen ingen af større Længde; de større Dale paa Nordlandet ere fyldte af Bræerne og Sydlandet synes at være meget lidet indskaaret af Dale. Af Bække ere kun faa iagttagne.

Karakteristiske for Jan Mayens Kyst ere de paa mange Steder opstaaende Klipper i Havet, hvoraf vi ovenfor have nævnt flere. De ere vistnok for største Delen Rester af Lavastrømme, der ere gaaede ud i Havet.

Jan Mayens Kyster ere, som ovenfor berørt, paa mange Steder meget bratte og høje. Paa andre Steder er der et lavt Forland, bestaaende af Lava, dækket tildels med Sand. Dette Forland, som paa Kartet har sin særegne Betegnelse, ligger tildels saa lavt, at det er dækket med Rækved. Lave Strender, af Sand, ere ogsaa mangesteds tilstede, og indeholde store Mængder af Rækved, Kjæver og Hvirvler af Hval, Vraggods og opkastet Tang.

reach a height of 400 to 600 feet. The altitude of Fugleberg we found by observation to be 490 feet; that of Egg Island was estimated at 400 to 500 feet.

As shown by Carl Vogt, the base of Mount Beerenberg is composed partly of layers of lava, and partly of layers of tuff, that would appear to have flowed or been discharged from the great central crater previous to the formation of the upper cone of ashes. The middle tract of the island exhibits a similar structure, and to judge from its appearance, also the southern part. Above this stupendous mass of lava rise a number of small parasitic craters, the greater part of which have retained a conical form. Such, for instance, are Sars's crater, the crater east of the southern glacier, the Esk and Vogt craters, Danielssen's and Blytt's craters, and the craters in the vicinity of Guinea Bay. Fugleberg on the west coast and Egg Island on the east, are no longer conical, the outer edge of the crater having given way and fallen into the sea. Some of the parasitic craters are built up of lava, and would appear to have sent forth considerable currents, as the Vogt and Esk craters; the summit of others consists of loose erupted masses, cinders, and ashes (rapilli), as the craters in the vicinity of Mary Muss Bay and Guinea Bay; others are composed of layers of tuff, tuff-conglomerate and compact masses of lava, as the Fugleberg, and others again of ashes alone, as Egg Island and the Berna crater.

The chief volcanic fissure in which Jan Mayen Island is built, must obviously extend in the longitudinal direction of the land, parallel to the volcanic line of Mount Hecla. Meanwhile, the grouping of the parasitic craters would seem to intimate the existence of transverse fissures running from WNW. to ESE.; for in that direction there are, apparently, several rows of parasitic craters, as the Esk, Vogt, Berna, the Fugleberg and Egg Island, Hoyberg and the crater in the vicinity of the "pilot-boat" (?). Must we regard it as mere accident that each of the terminal craters towards the south-east in the two first rows should have discharged ashes alone?

Jan Mayen has no valleys of considerable extent; the large ravines in the northern part of the island are filled with glaciers, and the southern land would appear to be but little intersected by vales or ravines. Of brooks or rivulets, very few have been observed.

A characteristic feature distinguishing the coast of Jan Mayen, are the fantastic-shaped rocks that in many places rise abruptly from the sea, of which we have mentioned several. They are no doubt in greater part fragments of lava detached from currents that had flowed into the sea.

The coasts of Jan Mayen are, as previously stated, in many places lofty and precipitous. In some localities, however, there is a low expanse of foreshore consisting of lava, partially covered with sand. This foreshore, which is separately marked on the Map, lies so low in places as to be covered with driftwood. Some localities, too, exhibit a low sandy beach, bestrewn with large quantities of driftwood, the jaws and vertebræ of whales, bits of wreck, and sea-weed.

Intetsteds paa Øen findes en Havn, der kan yde et Skib eller en Baad Ly i alle Slags Vejr.[1] Landgang paa Øen er derfor mulig kun naar Søen er forholdsvis rolig, men dette er vistnok en Sjeldenhed, undtagen naar Havisen ligger rundt om Øen.

Merkværdige ere de to Laguner, der ere adskilte fra Havet ved Volde af sort Sand, kun nogle faa Meter høje, et Par hundrede Skridt brede, som føre ferskt Vand og hvis Spejl kun ligger ubetydeligt højere end Havet. Vestsidens Lagune er saa dyb, at den vilde kunne give en god Havn, om Tangen blev gjennembrudt i tilstrækkelig Dybde. Østsidens Lagune er mindre dyb.

Jan Mayen ligger ganske i den østgrønlandske Polarstrøm. Under 10 til 20 Favne er Havets Vand hele Aaret igjennem iskoldt. Om Vinteren er der ofte aabent Vand ved Jan Mayen; navnlig passere Sælfangerne jevnlig vestenom Øen. Sommeren er kold, en naturlig Følge af det iskolde Vand.

Den nordlige Del af Jan Mayen er dækket af evig Sne indtil en Højde af omkring 700 Meter. Beerenbergs Kegle er snedækt undtagen paa de bratteste Steder, hvor den sorte Fjeldvæg træder frem. Beerenbergs Basis er dækket af en udstrakt Snekaabe, hvorfra vældige Isbræer skyde sig ned, af hvilke 9 store Bræer naa helt til Havet.

Sydlandet synes ikke at være glacieret. Store Sneflekker findes om Sommeren overalt paa Øen i Nærheden af Havet.

Jan Mayens Flora er fattig. Men det Grønne mangler ikke, tvertimod danner Mosernes grønne Teppe, der dækker store Partier, en udmerket malerisk Contrast til Bergarternes sorte, brune og røde Farver. De af Dr. Danielssen paa Ejdet i Syd for Mary Muss Bugten samlede Planter ere, ifølge Bestemmelse af Professor *A. Blytt*, følgende:

Saxifraga cæspitosa, L.
— *nivalis*, L.
— *oppositifolia*, L.
— *rivularis* L.
Ranunculus glacialis, L.
Halianthus peploides, Fr.
Cerastium alpinum, L.?
Draba corymbosa, R. Br.
Cochlearia officinalis, L.
Oxyria digyna, Campd.
Catabrosa algida, Fr.

Af *Pattedyr* findes Fjeldrakken, *Canis lagopus*, i ikke ganske ringe Antal paa Jan Mayen. Den synes at nære sig af Søfugl. Af Fugle har Hr. Friele noteret følgende Arter:

[1] Lille Sandbugt synes efter Beskrivelsen i Zeespiegel at afgive en god Baadhavn, dækket af udenfor liggende Skjærgaard.

Nowhere on the shores of Jan Mayen has a harbour been found that could afford a ship or a boat shelter in all kinds of weather.[1] Hence, to land is possible only with the sea comparatively smooth, which it rarely is save when drift-ice encompasses the island.

Specially noteworthy are the two lagoons, cut off from the sea by barriers of black sand, only a few feet high and a couple of hundred paces broad. They both contain fresh water, the surface of which lies but very little above that of the sea. The lagoon on the west side of the island is deep enough to afford a good harbour were the barrier cut through to a sufficient depth. The lagoon on the east side is comparatively shallow.

Jan Mayen lies wholly within the Greenland Arctic current. At a depth of from 10 to 20 fathoms, the temperature of the sea is all the year round below zero. In the winter there is frequently open water off the coasts of Jan Mayen, sealers often passing to the west of the island. The summer is naturally cold, from the presence of ice-cold water so near the surface of the sea.

The northern part of Jan Mayen rises, at a height of about 2300 feet, into the region of perpetual frost. The upper cone of Mount Beerenberg is snow-capt, save on the steepest parts of its declivity, where the black mountain-wall is seen protruding. The base of Beerenberg is girt with a belt of snow, from which prodigious glaciers take their origin, 9 of the largest reaching down to the water's edge.

The southern part of the island would not appear to be glaciated. Large patches of snow are everywhere observed throughout the summer in the vicinity of the sea.

Jan Mayen has but a meagre Flora. Bright herbage, however, is not wanting; the green carpet of moss, in places of considerable extent, forms a striking and pleasant contrast to the black, brown, and red of the surrounding rocks. The plants collected by Dr. Danielssen on the isthmus south of Mary Muss Bay, are, according to Professor *A. Blytt*, as follows: —

Saxifraga cæspitosa, L.
— *nivalis*, L.
— *oppositifolia*, L.
— *rivularis*, L.
Ranunculus glacialis, L.
Halianthus peploides, Fr.
Cerastium alpinum, L.?
Draba corymbosa, R. Br.
Cochlearia officinalis, L.
Oxyria digyna, Campd.
Catabrosa algida, Fr.

Of mammiferous animals, the Polar fox, *Canis lagopus*, is by no means rare on Jan Mayen. Of birds, Mr. Friele has noted the following species: —

[1] Little Sand Bay would appear, according to the account in the "Zeespiegel," to be a good harbour for boats, protected as it is by an outlying chain of islets.

Somateria mollissima, Leach. Sjelden.
Larus glaucus, Brün. Almindelig.
Fulmarus glacialis, Lin. Overordentlig talrig.
Grylle Mandti, Licht. Talrig.
Uria arra, Schlegel. Talrig.
Mergulus alle, Lin. Talrig.
Tringa maritima?

Er Landets Fauna fattig, er derimod Havets desto rigere, hvorom Vidnesbyrd vil foreligge i samtlige zoologiske Afhandlinger i denne Generalberetning.

Somateria mollissima, Leach. — Rare.
Larus glaucus, Brün. — Common.
Fulmarus glacialis, Lin. — Exceedingly abundant.
Grylle Mandti, Licht. — Abundant.
Uria arra, Schlegel. — Abundant.
Mergulus alle, Lin. — Abundant.
Tringa maritima?

If the land Fauna of the island is meagre, that of the sea is proportionately rich, a fact which the numerous zoological Memoirs published in this General Report will sufficiently attest.

Bemerkninger til Kartet.

Kartprojectionen er Mercators. Maalestokken 1:200,000. Navnene paa Kartet ere alle paaførte af mig. Jeg har for det første beholdt alle de gamle hollandske Navne, i Originalsproget eller oversatte. Dernæst har jeg beholdt alle de af Scoresby og Carl Vogt givne Navne. Og endelig har jeg tilføjet en Del nye Navne. Disse ere: *Weyprechts Bræ*, til Minde om den fremragende Polarfarer, hvis store Plan til Undersøgelse af Polarlandenes fysiske Forhold nu bliver realiseret; *Kjerulfs Bræ*, efter den berømte norske Geolog; *Foyns Bræ*, efter Capt. Svend Foyn, der var den første Nordmand, som gik i Spidsen for de Norskes Sælfangst ved Jan Mayen; *Krater Sars*, efter Expeditionens Medlem, Prof. G. O. Sars; *Clandeboye Creek*, det Punkt, hvor Lord Dufferin var i Land (efter velvillig skriftlig Meddelelse fra Lord D.; se ogsaa "Letters from High Latitudes", Side 165); *Lord Dufferins Bræ; Frieles Bræ, Griegs Bræ, Willes Bræ, Petersens Bræ, Schiertz's Top*, efter Deltagerne i vor Expedition; *Krater Vøringen*, efter Expeditionens Skib; *Høsaaten*, det lille Krater i Nærheden af *Hoyberg* (et Navn, der betegner et Tag over en Høstak, der minder om den regelmæssige Kegleform[1]); *Krater Danielssen*, efter Expeditionens Medlem, Dr. Danielssen, der botaniserede her; *Krater Blytt*, efter Prof. A. Blytt, der har bestemt de paa Jan Mayen indsamlede Planter; *Tornøes Bæk*, efter Expeditionens Medlem, Chemikeren H. Tornøe, som fandt denne, ret vandrige Bæk; *Scoresby's Berg*, efter den berømte Hvalfanger, hvem Jan Mayens Geografi skylder saa meget.

[1] Meddelelse af Dr. Snellen i Utrecht.

Remarks on the Map.

The Map is on Mercator's projection, scale $\frac{1}{200,000}$. All of the names are selected by myself. First, I have chosen to retain the old Dutch names, either in the original language or translated. Secondly, I have kept all the names given by Scoresby and Carl Vogt. And finally, I have added new names, viz. *Weyprecht's Glacier*, in memory of the renowned traveller, whose comprehensive plan for the investigation of the physical conditions of the Arctic Regions is now in course of realisation; *Kjerulf's Glacier*, after the celebrated Norwegian geologist; *Foyn's Glacier*, after Captain Svend Foyn, the first of his countrymen who started a Norwegian sealing fishery off the coasts of Jan Mayen; *Sars's Crater*, after Professor G. O. Sars, member of the Expedition; *Clandeboye Creek*, the spot where Lord Dufferin landed (as kindly communicated by that nobleman from Constantinople; see, too, "Letters from High Latitudes," p. 165); *Lord Dufferin's Glacier; Friele's Glacier, Grieg's Glacier, Wille's Glacier, Petersen's Glacier, Schiertz's Peak*, after gentlemen who took part in the Expedition; the *Vøringen Crater*, after the name of the vessel; *Hosaaten* (haycock), the small crater in the vicinity of Mount Hoyberg (Hoyberg is a Dutch word signifying the roof of a haystack[1] that in form has some resemblance to a volcanic cone); *Danielssen's Crater*, after Dr. Danielssen, member of the Expedition, who botanised on its slope; *Blytt's Crater*, after Professor A. Blytt, who has determined the specimens of plants collected on Jan Mayen; *Tornøe's Rivulet*, after Mr. H. Tornøe, chemist to the Expedition, who on one of our excursions found this for Jan Mayen copious spring of water; *Mount Scoresby*, after the enterprising British whaler to whom the geography of Jan Mayen is so greatly indebted.

[1] Communicated by Dr. Snellen of Utrecht.

Fra Hr. *H. Reusch*, Assistent ved den geologiske Undersøgelse, har jeg modtaget følgende Meddelelse om hans mikroskopiske Undersøgelse af nogle Bergarter fra Jan Mayen.

De Haandstykker fra Jan Mayen, som De velvilligen har tilstillet Universitetets Mineralkabinet, har jeg efter Professor Kjerulfs Opfordring undersøgt mikroskopisk. Der foreligger *Basalter* (Rosenbusch's Definition). Herved er dog at bemærke, at Olivinen, idetmindste tildels, er tilstede i noget ringe Mængde, og at Plagioklasen, i Modsætning til, hvad der for det meste finder Sted hos de ægte Basalter, for en Del forekommer porfyrisk indsprængt i større Individer. Alligevel har jeg ikke kunnet beslutte mig for Navnet Augitandesit.

Fire af Haandstykkerne, No. 4, 5, 6, 7, var temmelig ens; med blotte Øjne betragtet foreligger en temmelig rigelig, af smaa tomme Blærerum opfyldt, tæt, mørkegraa Bergart, hvori man ser fremskinne fine Feldspatlister og enkelte større Feldspatkrystaller, samt ogsaa bemærker en eller anden Augitkrystal, undtagelsesvis endelig ogsaa et lidet Korn grønlig Olivin.

Under Mikroskopet ser man en forholdsvis lidet finkornet Grundmasse af langstrakte Plagioklaskrystaller og mere rundagtige Augitindivider, fremdeles mørkt slaggeagtigt Glas og Korn af en mørk Jernerts. Udskilt i større, porfyrisk indsprængte Krystaller forekommer Plagioklas og Augit, hvilken sidste som Grundmassens er lys brunlig-grøn, meget svagt pleochroistisk. Hist og her i Præparaterne opdager man indsprængte større Olivinkrystaller, der er saagodtsom aldeles friske og for en stor Del omgrændsede af distincte Flader.

I de større Krystaller af de sidstnævnte tre Mineraler sees gjerne Glasindeslutninger og Jernertskorn, i Olivinen tillige Picotit (?).

De som No. 2 og 3 mærkede Haandstykker var ikke porøse og indeholdt talrigere samt mere fremtrædende porfyrisk udskilte Krystaller end foregaaende. I Grundmassen var Augiterne meget smaa; Jernerts var rigelig tilstede; lidt Biotit bemerkedes; Glas saa man kun lidet til. Derimod indeholdt de udskilte større Plagioklaskrystaller Indeslutninger af saadant som ogsaa af Grundmassen i vakkert rectangulært omgrændsede Partier. En paafaldende Finkornethed udmærkede den Olivinkrystallerne nærmest omgivende Del af Grundmassen, i hvilken forresten i dette lige saa lidt som i foregaaende Tilfælde Olivin bemærkedes som egentlig Bestanddel. Olivinen var dels omgrændset af Flader, dels havde den ujevne Omrids, dels endelig trængte Grundmassen med ujevnt conturerede, undertiden udpræget sækformede Forgreninger ind i dem. Disse Forgreninger var finkornede eller vel oftere et slaggeagtigt Glas, hvilket ogsaa gjerne optraadte i den til Krystallerne ellers allernærmest stødende Del af Grundmassen. Hosstaaende tre Figurer, der er tegnede ved 360 Ganges Forstørrelse, illustrerer nøjere dette Forhold. For Tydeligheds Skyld har jeg undladt at indtegne de Sprækker og Jernertskorn.

Mr. *H. Reusch*, Assistant to the Norwegian Geological Survey, has sent me the following results of his microscopical examination of divers rock-specimens from the island of Jan Mayen.

The rock-specimens from Jan Mayen which you kindly forwarded to the Mineralogical Museum of the University, I have, at Professor Kjerulf's request, submitted to microscopic examination. They are *basalt* (Rosenbusch's definition). I must, however, observe, that in some cases olivine is present in no great proportion, and that plagioclase, as an exception to the general rule in true basalt, occurs here and there porphyrically imbedded in crystals of considerable size. Nevertheless, I cannot decide for augite-andesite.

Four of the specimens, Nos. 4, 5, 6, and 7, are comparatively uniform in appearance. To the naked eye, their aspect is that of a dark-grey rock exhibiting numerous empty vesicles, together with glistening lines of feldspar and several large crystals of that substance; one or two crystals of augite may be likewise observed, and finally minute isolated granules of greenish olivine.

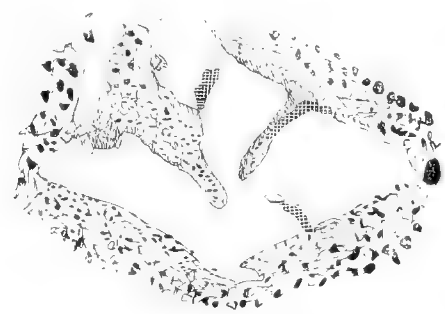
Viewed under the microscope, is seen a comparatively coarse base of elongated plagioclase crystals, along with crystals of augite, rounder in form, dark slaggy glass, and grains of a dark-coloured iron ore. Plagioclase and augite occur imbedded in comparatively large crystals, the latter having, in common with that of the base, a brownish-green tint; it is, too, to a very slight extent pleochroistic. Every here and there in the prepared specimens are observed comparatively large imbedded crystals of olivine, with scarcely a trace of decomposition, and having on all sides well-defined facets.

In the three last-mentioned minerals are seen cavities containing glass and grains of iron ore; in the olivine also picotite (?).

Specimens No. 2 and 3 are not porous; moreover, they differ from those described above in having a greater number of porphyrically imbedded crystals, which are also more obvious. In the base, the grains of augite are exceedingly minute; iron ore is present in great abundance; a little biotite, too, was observed, but only traces of glass. On the other hand, the large plagioclase crystals exhibited numerous cavities containing the latter substance, as also that of the base, in beautifully formed rectangular spots. The part of the base immediately surrounding the crystals of olivine exhibits a remarkably fine granulation, though for the rest, neither in these nor any of the foregoing specimens does olivine occur as a true basic constituent. The crystals of olivine have some of them plane surfaces, others irregular outlines, and some are pierced by the substance of the base with irregular, and possibly also saclike, ramifications. These ramifications are either finely granular, or, more frequently perhaps, consist of slaggy glass, which often occurs too in the part of the base contiguous to the crystals. The three figures given below, showing the object as it appeared under the microscope

som tildels sees i Olivinkrystallerne. Det mørke med korsvise, hvide Linjer, som sees indtrængende i Olivinen er urent, slaggeagtigt Glas, det sorte Mineral i Omgivelsen er Jernertskorn.

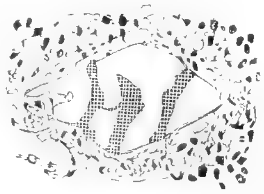
(magnifiing 360 diameters), will supplement the verbal description. To avoid complexity in the drawing, I have left out the fissures and the grains of iron ore that are seen in some of the crystals of olivine. The dark substance, with intersecting white lines, seen piercing the olivine, is discoloured, slaggy glass, the black particles lying around, grains of iron ore.



Olivinkrystal i Basalt. — A Crystal of Olivine in Basalt, magnified.

Den omgivende Bergart er paafaldende finkornet indved Krystallen og trænger i sækformede Forgreninger ind i denne.

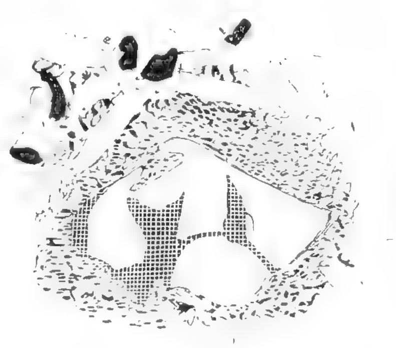
The surrounding rock exhibits a remarkably fine granulation in immediate proximity to the crystals, which it pierces in sac-like ramifications.



Olivinkrystal i Basalt. — A Crystal of Olivine in Basalt, magnified.

Urent Glas indtrængende fra den omgivende temmelig finkornede Bergart.

Discoloured glass is seen piercing the crystal from the surrounding rock, which has a fine granulation.



Olivinkrystal i Basalt. — A Crystal of Olivine in Basalt, magnified.

Den omgivende Bergart er finkornet. Øverst paa Tegningen sees Basalt af den herskende Kornighedsgrad. Urent Glas trænger ind i Krystallen fra Omgivelsen.

The surrounding base is finely granulated. — At the top of the figure is seen basalt of the dominant degree of granulation. Discoloured glass pierces the crystal from the rock surrounding it.

Disse mikroskopiske Forhold minder unægtelig om Eruptiver, som bliver finkornede paa sine Grænser og sender finkornede Forgreninger ud i de omgivende Bergarter. Hvorvidt her foreligger et Atkjolingsfænomen er dog tvivlsomt; maaske Olivinen allerede ved sin Udkrystallisation har paavirket Grundmassen, saa den i dens umiddelbare Nærhed har stivnet hurtigere. Lignende Forhold som disse ved Olivinen beskrevne iagttages, om end mindre karakteristisk, ved de udskilte Plagioklas- og Augitkrystaller.

Haandstykket No. 8 er porøst, af en forholdsvis lys, rødliggraa Farve og indeholder udskilte Augitkrystaller. Under Mikroskop ser man, at Bergarten, som er forholdsvis lidet grovkornet og lidet rig paa mindre Augitindivider, indeholder en hel Del Olivin. Dennes Individer udhæver sig ikke synderlig i Størrelse fremfor de øvrige Bestanddele; den er ikke som i de foregaaende Tilfælde frisk, men underkastet en begyndende Serpentinisering ledsaget af Udskillelse af Jernoxyd, som er det, der gjør Bergarten rødlig. Slaggeagtigt Glas er temmelig rigelig tilstede. Nogle lange fine Naale i Feldspaten formodes at være Apatit.

Haandstykket No. 1 udmærker sig fra de beskrevne makroskopisk derved at det ingen porfyrisk udskilte Feldspatkrystaller indeholder, men derimod en Mængde smukke gulagtiggrønne Olivinkrystaller, som er indtil 0.5 cm. store.

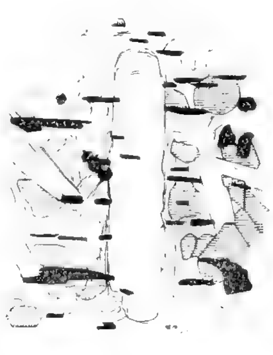
Under Mikroskopet ser man, at Hulrummene gjerne er omgivne med en Zone af Glas. I Olivinen, der synes at være udkrystalliseret efter en anden Typus end foregaaende, bemærkes hyppig det som Picotit tydede Mineral. Den mørke Jernerts er tilstede ikke alene i rundagtige Korn, men ogsaa i stavformede Legemer. Disse forekommer som Regel nær Olivinkrystallerne og har en bestemt Stilling til disse, uanseet Bergartens øvrige paa kryds og tvers liggende Bestanddele. De staar, saavidt jeg har kunnet iagttage det, lodret mod Olivinernes Hovedakse, parallelt deres lange Biakse; de staar nemlig lodret mod deres bedste Gjennemgangsretning. Man faar Indtrykket af, at Bergartens først udskilte Bestanddele, Olivinen og Jernertsen, i den endnu plastiske Masse har ordnet sig i et bestemt Forhold indbyrdes.

These microscopic details are undeniably suggestive of eruptive rocks that exhibit a fine granulation at their limits and send forth finely granulated ramifications. Whether we have here the result of some cooling process is doubtful; possibly, the olivine acted in the course of its crystallisation upon the basic substance, thereby causing the latter in its immediate vicinity to harden sooner. A similar feature, though less characteristic than in the olivine, distinguishes the imbedded crystals of plagioclase and augite.

Specimen No. 8 is porous, of a lightish ruddy-grey colour, and contains imbedded crystals of augite. Viewed under the microscope, this rock, which, comparatively, has not a coarse granulation and exhibits but few particles of augite, contains a good deal of olivine. The crystals of the latter substance are not very large as compared with its other constituents: the olivine is not as in the foregoing specimens undecomposed, but exhibits distinct traces of serpentinisation, along with the formation of oxide of iron. This it is which gives a red colour to the rock. Slaggy glass occurs in comparative abundance. A few long thin crystals in the feldspar would appear to be apatite.

Specimen No. 1 is distinguished macroscopically from those described above, by its not containing imbedded crystals of feldspar; it exhibits, however, an abundance of beautiful yellowish-green crystals of olivine, measuring up to 0.5 cm.

Viewed under the microscope, the hollow cavities are found to be encompassed by a zone of glass. The olivine exhibits a type of crystallisation different to that observed in the other specimens, and contains a greater proportion of picotite than usual. The dark iron ore occurs not only in roundish grains, but also in rod-shaped corpuscles. These corpuscles are as a rule observed in immediate proximity to the crystals of olivine and have a definite position towards them, irrespective of the other constituents of the rock, that run in all directions. They are placed, so far as I could determine, perpendicular to the vertical axis of the crystals, and parallel to the macrodiagonal, being perpendicular to the most perfect cleavage. The first-formed constituents of the rock, olivine and iron ore, would appear to have taken up a definite position one towards the other while the surrounding mass was yet plastic.



Olivinkrystal i Basalt. - A Crystal of Olivine in Basalt.

Den i stavformede Legemer forekommende Jernerts har en bestemt Stilling i Forhold til Olivinkrystallen. Tegnet ved 360 Ganges Forstørrelse.

The iron ore occurring as rod-shaped corpuscles has a definite position towards the crystal of olivine. — Microscope magnifying 360 diameters.

3. Beeren Eiland.

Den 4de Juli 1878 kom Expeditionen tidlig om Morgenen op under Beeren Eiland. Taagen, som laa over Øens højere Dele, sprędte sig efterhaanden, og om Formiddagen blev Vejret ganske klart. Vi ankrede udenfor den saakaldte "Russestue", et forfaldet lidet Hus, der dog tidligere skal have været Bolig for et overvintrende Parti. Gjennem "Borgermester-Porten"[1] roede vi ind i den lille Bugt, ved hvis inderste Bred Russestuen ligger. Vi medhavde fra Bergen en Post til den hollandske Expedition med Skonnerten "Willem Barendsz," hvilken efter den af den hollandske Consul meddelte Anvisning nedgroves, indlagt i en dobbelt Kasse, i Nærheden af Huset. Stedet merkedes med et Flag, hvorpaa stod malet: "'Vøringen' til 'Willem Barendsz'." Vi havde senere paa Sommeren den Tilfredsstillelse at erfare, at Hollænderne havde fundet sin Post.

Vort af stormende Vejr og Modvind forlængede Ophold i Østhavet tillod os ikke at offre mere end en halv Dag til et Besøg paa Beeren Eiland. Jordbunden bestod omkring Russestuen af lutter forvitret Sten, en ren "Forvitringshud," der i Frastand gav Landet et aldeles "graaskaldet" Udseende. Om Morgenen toges Skitser af Beeren-Eilands Sydvestpynt. Billeder af denne findes i Beretningerne om de Svenske Spidsbergen-Expeditioner 1861 og 1864. Da vi vare i Land om Formiddagen, og efter at være kommen ombord igjen, tog jeg Skitser af Øens højeste Fjeld, Mount Misery. Fig. 8 er skaaret efter en Tegning, der er gjort efter disse Skitser. Man ser her Beeren-Eilands Sydostpynt til Højre. Udenfor viser sig Drivis, der kommer fra Nordost. Gjennem Mount Misery gaar et horizontalt Lag af en ejendommelig fremtrædende Bergart med, som det synes, verticale Afsondringsflader. Forsaavidt man kan dømme af Udseendet alene i Frastand, synes denne Bergart at være den af Nordenskiöld benævnte Hyperit, der forekommer paa aldeles lignende Maade paa Spidsbergen og hvis Forekomstmaade sees af flere Billeder i Beretningerne om de Svenske Spidsbergens-Expeditioner.

Højden af Mount Misery's øverste Top bestemte jeg paa følgende Maade. Fra et Punkt i Land, hvor der var oprejst en liden Stenvarde, maalte jeg med Sextant Vinkelhøjden (0° 50′ 0″) af Vøringens Stormast (der efter et nøjagtigt taget Maal udgjorde 21.39 Meter). Dette giver en Afstand mellem Stenvarden og Ankerpladsen af 1470 Meter. Ved Stenvarden var Lufttrykket 744.mm0, medens det ombord, i Havets Niveau var 750.mm7. Luftens Temperatur var 5° C. Stenvardens Højde over Havet beregnes herefter til 73 Meter. Endvidere maalte jeg med Sextanten Vinkelen mellem "Vøringen" og Toppen af Mount Misery

[1] Se "Svenska Expeditionen till Spetsbergen År 1864 ombord paa "Axel Thordsen," under Ledning af A. E. Nordenskiöld". Side 16.

3. Beeren Eiland.

On the 4th of July, 1878, early in the morning, the Expedition reached the coast of Beeren Eiland. A thick fog, which lay over the loftiest parts of the island, gradually dispersed, and in the course of the forenoon the weather became quite clear. We anchored off the so-called "Russian Hut," an old, neglected cabin, which is said, however, to have once served as a winter abode for a party of sailors. Passing through the "Borgermester-Porten"[1] (burgomaster's gate), we rowed into the small bay at the head of which stands the Russian Hut. We had with us from Bergen a bag of letters for the Dutch Expedition with the schooner, "Willem Barendsz," which, in accordance with directions given by the Dutch Consul, was now buried near the cabin, after being laid in a double case. We marked the spot with a flag, on which had been painted the words: "'Vøringen' til 'Willem Barendsz'." Later in the season we had the satisfaction of learning that the Dutch explorers had found their letters.

The boisterous weather and the succession of contrary winds that had protracted our cruise in the Barents Sea, would not admit of our devoting more than half a day to an excursion on Beeren Eiland. The ground in the vicinity of the Russian Hut consists exclusively of disintegrated stones, — in the strictest sense a "weathered crust," which at some distance gives to the land a grey, bald appearance. In the morning we sketched the south-western promontory of Beeren Eiland. Views of this headland are given in the accounts of the Swedish Spitzbergen Expeditions in 1861 and 1864. When on shore in the forenoon, and after returning to the vessel, I sketched the highest summit of the island, Mount Misery. The view in Fig. 8 is from these sketches. To the right, we have the south-eastern headland of Beeren Eiland. Beyond, is seen drift-ice bearing down upon the island from the north-east. Traversing Mount Misery, we observe a layer of a peculiar conspicuous rock, having apparently a vertical columnar structure. To judge from its aspect at a distance, this rock would appear to be of the kind designated by Nordenskiöld as hyperite, that occurs under precisely the same conditions on Spitzbergen, and the structure of which is illustrated in several of the figures accompanying the accounts of the Swedish Spitzbergen Expeditions.

The altitude of Mount Misery was determined as follows. From a point on shore, at which a mound of stones had been erected, I measured with the sextant the angle of elevation (0° 50′ 0″) of the main mast of the "Vøringen," which, according to accurate measurement, had a height of 21.39 metres. The said angle corresponds to a distance between the mound and the anchorage of 1470 metres. At the mound, the barometric pressure was 744.mm0, whereas on board (at the level of the sea) it was 750.mm7. The temperature of the air was 5° C. From these data, the height of the mound above the sea-level was computed at

[1] See "Svenska Expeditionen till Spetsbergen År 1864 ombord paa 'Axel Thordsen,' under Ledning af A. E., Nordenskiöld," p. 16.

(111° 22′) og Toppens Vinkelhøjde over Horizonten (8° 40′). Horizonten bestemtes ved Hjelp af Wredes Niveller-Spejl, med hvilket jeg merkede mig et tydeligt Punkt paa Fjeldet ret under Toppen, i Stenvardens Niveau. Kommen ombord maalte jeg Vinkelen mellem Stenvarden og Toppen af

Fig. 8. Mount Misery.

Mount Misery (48° 9′) samt Toppens Højdevinkel over Horizonten (7° 56′, corrigeret for Kimmingdaling). Herefter beregnes Afstanden Stenvarde—Top til 3914 Meter, Afstanden Skib—Top til 3131 Meter, og Højdeforskjellen mellem de to første Punkter til 472 Meter, mellem de to sidste til 541 Meter. Lægges hertil de respective Standpunkters Højde over Havet, 73 Meter og 3 Meter, faaes som Resultat 545 og 544 Meter. Den sidste Bestemmelse har jeg antaget som den sikreste, og sætter saaledes Mount Miserys Højde til 544 Meter eller 1785 engelske Fod. Dette er et større Tal end den paa Søkarterne, formentlig efter et Skjøn, angivne Højde af 1200 Fod.

73 metres. Moreover, I measured with the sextant the angle subtending between the "Voringen" and the summit of Mount Misery (111° 22′), as also the angle of elevation of the latter above the horizon (8° 40′). The horizon was determined by means of Wrede's levelling-mirror, with which I marked a point on the mountain, in the vertical plane of the summit, and level with the mound. On returning to the vessel, I measured the angle subtending between the mound and the summit of Mount Misery (48° 9′), as also the angle of elevation of the latter above the horizon (7° 56′, corrected for the dip). The distance between the mound and the summit was then computed, and found to be 3914 metres, that between the ship and the summit 3131 metres, and the difference in altitude between the two first-mentioned points 472 metres, between the two last-mentioned 541 metres. Now, if to these figures be added the height above the sea of the respective standpoints, viz. 73 metres and 3 metres, the result will be 545 and 544 metres. The latter determination I regard as the more trustworthy of the two, and have therefore put the altitude of Mount Misery at 544 metres, or 1785 English feet above the sea-level. This exceeds the height given in the charts — 1200 feet, the result probably of estimation.

Den 1ste August 1878 laa Expeditionen under Nordostsiden af Beeren Eiland for at have Ly for den paa Havet blæsende Sydvest Storm. Da Vejret om Aftenen syntes at bedage sig, forsøgtes at lande paa Øen. Dette lykkes ogsaa. Vi kom i Land ved Mundingen af Engelsk-Elven, der ved sit Udløb i en liden Bugt danner en Fos. Vi steg op paa Beeren-Eilands flade Plateau, der fandtes at ligge omtrent 34 Meter over Havet, og vandrede en Mils Vej nordover. Kysten er overalt ganske brat, flere Steder helder Fjeldvæggen udover. Den er dannet af horizontale Lag, der som bekjendt tilhøre Stenkulperioden. Fra Søen af ser Kystlinien temmelig ret ud, men fra Land viste den sig at bestaa af fremspringende Nes afvexlende med indgaaende Bugter. Brændingen arbejder uafladelig paa at udgrave de lavere Lag. De overliggende Lag miste sit Underlag, brydes af og styrte i Stranden, hvor de søndermales af Bølgeslaget. Paa Land saa vi, indenfor Plateauets Rand, gabende Sprækker, der havde dannet sig ved de undergravede Lags begyndende Synkning. I Fjæren saa vi, hvorledes Bølgerne tumlede vildt med det nedrasede Lands Rester. Ved enkelte Nes staar igjen Stabber eller Søjler, adskilte fra Landet, ogsaa som Vidnesbyrd om Havets Magt. Disse Stabber, med sine horizontale Lag, frembyde søgte Hækkepladse for talløse Søfugle, der her kunne være i Fred for Fiender. Saaledes skrider Beeren-Eilands Ødelæggelse frem. Den grunde Banke, der strækker sig fra Øst-Spidsbergen til Beeren-Eiland, er sandsynligvis for en stor Del Resterne af dette Land. Nu kommer hertil det faste Materiale, som Drivisen fører med sig og afsætter ved sin Smeltning.

Vort Billede viser denne Kyst med de udoverhængende Lag, de fremstikkende Nes, de af Bølgerne udhulede Bugter, i hvilke Brændingen arbejder, og to af de fritstaaende Stabber.

Inde paa Sletten passerede vi, i en Afstand af et Par Kilometer fra Kysten, en Række smaa grunde Ferskvandsøer, hvis Vand havde en Temperatur af 9° C., og som syntes at være et yndet Opholdssted for talrige Søfugle. Overfladen af Fjeldet bestod af lutter løse Stene, dels som løs Ur, dels som mindre Stene med Jord imellem, der frembød en Smule Vegetation. Hist og her fandtes sammenhængende Mostepper.

On the 1st of August, 1878, the "Vøringen" rode at anchor off the north-east coast of Beeren Eiland, during a heavy gale from the south-west. In the evening, the weather having somewhat abated, an attempt was made to land on the island. It proved successful. We landed at the mouth of English River, which forms a cataract where it disembogues into a small bay. We ascended to the plateau of Beeren Eiland, that attains an elevation of about 110 feet above the sea, and strolled for a few miles in a northerly direction. The coast is everywhere precipitous, in several places with beetling cliffs. It is built up of horizontal strata belonging to the true carboniferous era. As seen from the sea, the coast appears to extend in a comparatively unbroken line; but on landing, it was found to form numerous headlands and bays. The ceasless action of the surf gradually wears away the lower strata. The upper layers being thus deprived of their support, give way, and topple down into the sea, where they are broken up by the lashing of the waves. Near the edge of the plateau were seen yawning rents in the surface, showing that the subjacent layers were about to give way. On the beach, we could observe the action of the waves in tossing about the fallen masses. Stumps or columns of rock still remain off some of the headlands, — another proof of the marvellous power of the waves. These columnar rocks afford favourite breeding-haunts for sea-fowl, where they have nothing to fear from their enemies. Thus proceeds the gradual demolition of Beeren Eiland. The bank extending from East Spitzbergen to Beeren Eiland, is probably in greater part the remains of this land, along with the solid matter deposited on the melting of drift-ice.

Our view of this coast shows the beetling stratified cliffs, the bold projecting headlands, the bays and creeks hollowed out by the sea, in which the surf is for ever engaged in its work of destruction, and two of the isolated columnar rocks.

On the plateau, about a mile from the coast, we passed a chain of small freshwater lakes, apparently the favourite resort of innumerable wild-fowl; the temperature of the water was 9° C. The surface of the island consisted exclusively of loose materials, in part dry gravel, in part small stones embedded in earth exhibiting traces of vegetation. Here and there was seen a carpet of moss.

4. Spidsbergen.

Den 5te August 1878 fik vi for første Gang Øje paa Spidsbergen. Ved Middag saaes Syd-Spidsbergen forud, et skydækket Land med Sne og Isbræer. Udenfor Sydkap ligge nogle ganske lave Øer. Vi sejlede søndenom disse og

4. Spitzbergen.

On the 5th of August, 1878, we got our first view of Spitzbergen. About noon the "Vøringen" bore down on South Spitzbergen, a cloud-capt land, with snow-fields and glaciers. Off South Cape are seen a number of small,

aflagde et kort Besøg i Storfjorden. Det var en ejendommelig smuk Aften. Foran os laa, som Billedet viser, Sydkap med sine Sne- og Isbræer, af hvilke en næsten naaede Havet. Fjeldtoppene vare paa Vestsiden indhyllede i Skyer, fremkaldte af den herskende Vestenvind. Paa Østsiden derimod, imod Storfjorden, var Himmelen klarere, og ude i Horizonten mod Øst var der aldeles klart Solskin. Men Himmelen var ikke blaa, den havde et forunderligt sterkt gult Skjær, som først i Sydost gik over til det vante blaa. I Nord for det egentlige Sydkap saaes "Keilhaus Fjeld", og mellem dette og Sydkap fremtraadte Billedets interessanteste Gjenstand, en Isbræ, der fra det Indre af Landet med sagte Skraaning steg ned til og langt ud i Havet, hvor den endte med en tverbrat Væg, kanske sine 30 Meter høj, og hvis horizontale Udstrækning kunde maales med Kvartmile. Ved Synet af denne Ismasse, paa hvis Overflade Solens Straaler fremkaldte et blændende hvidt Lys, medens den bratte Endevæg laa som en lang, mørk Rand eller Skygge langs Havbrynet, med den sterkeste Modsætning til hin, kunde jeg forstaa, hvorfor vore Fangstfarere kalde Isbræerne for Is-*Fjelde*. Et saadant Fjeld gjør, som det her træder frem, den samme Berettigelse gjældende paa at deltage i Rækken af de Masser, der bygge den faste Jord, som den massiveste Granit. Vort Billedes Forgrund danner det spejlblanke, kun nu og da af en svag Bris krusede, men dog altid gyngende Havspejl, med sit gjennemsigtige, grønne Vand, i hvilket Isflag og Isblokke af de mangfoldigste og forunderligste Former ligge omstrøede. Her sees et fladt Stykke, ovenpaa dels blændende hvidt af Sne, dels tilsmudset af jordagtige Stoffe, med blaa Sprækker og smukt blaagrønt under Vandet — det er Vandets egen Farve. Hist et Stykke som en Svane med sin lange Hals, en hyppig Fremtoning hos Polarisen.

low-lying islands. We passed to the south of these islets, and steamed a short distance up the Stor Fjord. It was a lovely night. Before us, as shown in the prospect, lay Cape South, with its snow-fields and glaciers, one of which reached almost to the water's edge The summits on the west coast were wrapped in clouds driving before the westerly wind. On the east shore, in the direction of the Stor Fjord, the atmosphere was considerably clearer, and on the eastern horizon the sun shone brightly. The sky, however, was not azure; it had a strange yellowish tint, that extended to the south-east before merging into the wonted cerulean hue. North of the promontory forming Cape South, was seen "Mount Keilhau;" and between this summit and the headland lay, boldly defined, the most interesting object in the view, a stupendous glacier, which, with a gentle declivity, extended from the inland tracts to the shore and far out into the sea, where it terminated in a perpendicular wall, at a rough estimation not less than 100 feet high, and horizontally stretching for miles. Regarding this prodigious mass of ice, from the surface of which the rays of the sun were reflected in dazzling brightness, whereas its terminal wall extended, in striking contrast, as a dark line or shadowy limit along the surface of the ocean, the name of "Is-Fjelde" (Ice Mountains), given by our seamen to these Spitzbergen glaciers, was seen to be singularly appropriate. One of these glacial bergs is equally entitled to rank as a component part of the masses that constitute the land as granite itself. In the foreground of the picture, curled here and there by a gentle wind, the ocean expands its ever restless bosom, on which floes and fragments of ice of every conceivable form lie scattered around. Here, we have a huge flat block — its surface covered partly with snow of a dazzling whiteness and partly with some dark earthy substance — exhibiting blue fissures, and having under the water a beautiful bluish-green tint, the colour of the surrounding ocean. There, is seen a fragment resembling a swan, with its long extended neck, a form frequently assumed by the Polar drift-ice.

Den 15de og 16de August 1878 laa Expeditionen til Ankers ved *Norsk Øerne* paa Nordkysten af Vestspidsbergen. Der indtoges en Del Ballast, til hvilken Stene af passende Størrelse kunde hentes i Fjæren lige ved Sundet mellem Norskøerne. I dette var der en sterk Tidevandstrøm, der førte Ismasser østenfra ind i Sundet og siden med skiftende Strøm tilbage. Vort Billede Fig. 9 viser Udsigten fra Ankerpladsen mod Nord. Til Højre Ydre Norskø, fra hvis Top man i klart Vejr kan se østover helt til Verlegenhuk. I Billedets Midte se vi Toppen af Øen "Cloven Cliff," der i vest-ostlig Retning har en Klov eller Kløft. Vi se paa Billedet, hvorledes Lyset falder ind gjennem denne. Til Venstre er Øen Vogelsang. Udenfor Øerne

The 15th and 16th of August, 1878, the Expedition passed at anchor at the *Norway Islands*, on the north coast of West Spitzbergen. Here we took in ballast, stones of suitable size forming the beach of the sound that extends between the islands. In this sound there was a strong tidal current, that brought with it, when setting from the east, considerable quantities of drift-ice, but which, on the turn of the tide, carried it back again. The view in Fig. 9 is from the anchorage, looking north. To the right we have Outer Norway Island, from the summit of which, in clear weather, you can see in an easterly direction as far as Verlegen Hook. The middle part of the picture shows the summit of the island, "Cloven Cliff," a

ligger Taagen over Havet. I Sundet sees et Par Fartøjer tilankers. Det er norske Torskefiskere, der her gjøre et rigt Fiske. Sluppen er den bekjendte „Isbjørn", der i 1871 førte Weyprecht og Payer og i 1872 Grev Wilczek paa deres Polarfærder til Spidsbergen og Østhavet.

rocky mount that from west to east exhibits a long rent or chasm. In the view, we see how the light falls into this ravine. To the left, rises the island of Vogelsang. Off the islands, a dense fog lies over the sea. In the Sound, one or two vessels are seen riding at anchor. They are Norwegian ships engaged in the Spitzbergen cod-fishery, which hereabouts is very productive. One of the vessels is the "Isbjørn", the well-known cutter that in 1871 took Weyprecht and Payer, and in 1872 Count Wilczek on their exploratory voyages to Spitzbergen and the Barents Sea.

Fig. 9. Cloven Cliff.

Om Aftenen den 16de August sejlede Expeditionen ned gjennem Smeerenberg-Sundet, hvor vi saa vort største Isberg, c. 23 Meter højt, staaende paa Grund der hvor South-Gat begynder. Vi passerede South-Gat efter det i 1818 af Beechey og Franklin optagne Kart, og ankrede ved Midnat i Magdalena Bay, indenfor „Begravelsespladsen".

Magdalena Bays storartede Glacialnatur er udmerket

In the evening of the 16th of August, the Expedition steamed through Smeerenberg Sound, and we had a fine view of the largest iceberg seen on any of our cruises. It had grounded in the inner part of South Gat. Its elevation was estimated at about 70 feet. We steered through South Gat by the chart constructed in 1818 by Beechey and Franklin, and cast anchor in Magdalena Bay, within the "burial ground."

The grand glacial scenery of Magdalena Bay is ad-

vel gjengivet i Plancherne til Gaimards Rejse med "la Recherche". Vort Billede, der viser Sydsidens Bræer, er taget fra den fremspringende Landtunge "Begravelsespladsen". I Forgrunden sees, hvorledes det ser ud paa en Campo santo paa Spidsbergen. Til Venstre se vi Landtungen, der forbinder Begravelsespladsen med Land, og udenfor denne den saakaldte Gully's Glacier. Dennes Ende hviler for en stor Del paa Fjæren, langs hvilken jeg passerede foran den, men i Midten gaar Bræen ud i Havet og her losner stadig Stykker af den. Jeg blev Vidne til et saadant Skuespil. En høj Issøjle løste sig med et Brag fra Bræens yderste Væg. Den heldede udover og begyndte sit Fald med en svingende Bevægelse, støttet paa sin underste Ende. Jeg ventede at se den falde med hele sin Sideflade i Vandet, men dette skede ikke. Da den havde svunget udad en 30 Grader fra Verticalen, sank hele Issøjlen med Et sammen med en gjennemgaaende Verticalbevægelse, knustes og strøedes som mindre Stykker over Søen, der ved Faldet sattes i sterk Bølgegang. — Jeg var oppe paa Bræen paa dens Nordside; den var uden større Sprækker og havde en meget jevn Overflade.

I det indre Basin af Magdalena Bay gjenfandt jeg de af Charles Martins i 1839 maalte lave Dybtemperaturer. Bundtemperaturen var her — 2.°1, den laveste Temperatur i Havet, jeg havde fundet paa hele vor Expedition. Og her var et rigt arctiskt Dyreliv.

mirably rendered in the Plates annexed to Gaimard's voyage with "la Recherche." Our view of the glaciers of the south-coast is taken from the tongue of land termed "the burial ground." In the foreground, we have the aspect of a Campo Santo on Spitzbergen. To the left stretches the isthmus connecting the burial-ground with the main land, and off the former rises the so-called Gully's Glacier. The terminal portion of this glacier rests in greater part on the beach, along which I strolled below it; but the middle section projects into the sea, and here large fragments are continually breaking off. I was myself a witness of this gradual dismemberment. A lofty column of ice parted with a loud crash from the outer wall of the glacier. Supported at its lower end, the fall commenced with a slow, swaying movement. I expected to see it strike the water with the whole of its lateral surface, but in this was mistaken: having swung some 30 degrees out of the perpendicular, the entire column suddenly collapsed, taking a well-nigh vertical direction, and was smashed to pieces, the fragments being scattered over the sea, which became violently agitated by the shock. I had ascended the glacier from the north side; its surface was remarkably even and exhibited no considerable fissures.

In the inner basin of Magdalena Bay I observed the low deep-sea temperatures found by Charles Martins in 1839. The bottom-temperature was — 2.°1 C., the lowest temperature I at any time observed in the water of the sea on the cruises of the Expedition. And yet these depths disclosed an abundance of animal life.

Fra den 19de til den 22de August laa Expeditionen tilankers i Advent Bay, Isfjorden, Spidsbergen, medens Maskinen eftersaaes. Denne Anledning benyttede Capt. Wille til at optage et nøiagtigt Kart over Advent Bay, der ofte besøges af norske Fangstfartøjer. Eftermiddagen den 19de benyttedes til en Recognoscering, og der opsattes nogle Signaler. Den 20de om Morgenen tog jeg paa Odden (Basis A) en Række Solhøjder. (Se H. Mohn. Astronomiske Observationer Side 19). En Grundlinie blev udstukket og merket med Teltpinde paa det flade og jevne Terræn langs Stranden. Grundlinien er i Kartet optrukket mellem Punkterne A og B. Horizontalvinklerne til de nærmeste Signaler maaltes med Theodolit. Ved Middagstid bestemtes Azimut af Linien A C med Theodolit og Solen af Capt. Wille og mig i Forening. Derpaa fik jeg atter nogle Solhøjder. Om Eftermiddagen rejste Capt. Wille med Baad rundt den indre Del af Bugten og maalte med Sextant Horizontalvinklerne mellem de opsatte Signaler. Samtidig hermed maalte jeg Grundliniens Længde. Jeg benyttede hertil 3 Træstænger, af tilsammen 9.112 Meters Længde, ret afskaarne for Enderne. Disse lagdes af mine Assistenter, Baadsmanden og en Matros, fra Basis B af paa Jorden,

From the 19th to the 22nd of August, the "Vøringen" lay at anchor in Advent Bay, Ice Sound, Spitzbergen, her engines having to be cleaned and examined. Capt. Wille took advantage of this opportunity to construct a map of Advent Bay, a locality which is frequently visited by Norwegian fishing vessels. The afternoon of the 19th was devoted to reconnoitring in the vicinity of the Bay, and a few signals were erected. On the morning of the 20th, I took from the tongue of land (Base A) a series of solar altitudes (See H. Mohn. Astronomical Observations, p. 19). A base line was marked out with tent-pegs along the flat, beachy strand. On the Map, the base line extends between the points A and B. About noon, Capt. Wille and myself determined with the theodolite the azimuth of the line AC by the sun. I then succeeded in taking another series of solar altitudes. In the afternoon, Capt. Wille rowed round the inner shore of the Bay, and measured with the sextant the horizontal angles between the signals. Whilst he was thus engaged, I measured the length of the base line. For this purpose, I made use of three wooden rods, cut straight off at the ends, measuring together 9.112 metres. These rods were placed on the ground by my two assistants, the

i Numerfølge, I, II, III, og indsigtedes ved Øjemaal i Linien. Det blæste en liden Bris tvers paa Linien og Operationen gik let ved at commandere "luf" og "fald". Naar Stængerne flyttedes, satte jeg Foden paa den sidste Stang, indtil den næste var sat til dens Ende og orienteret. Maalingen kunde saaledes paa det flade Terræn blive ret nojagtig. Grundliniens hele Længde fandtes ved Hjelp af Stængerne og et Metermaal at være 299.11 Meter. Nogen merkelig Reduction for Stængernes Heldning har jeg ikke fundet det praktisk nodvendigt at anbringe. Metermaalet, der anvendtes som Normalmaal, er et i Paris kjøbt, med Regjerings-Stempel forsynet Træmaal til at lægge sammen. Det er henimod en Millimeter længere end et Par andre herværende Meterscalaer af omhyggeligere Construction. Dette Overskud kan regnes at gaa op imod den ved Maalestængernes Heldning og unojagtige Orientering fremkomne Fejl. Efter Afslutningen af Grundliniemaalingen opsatte jeg Signalerne Y, T og videre vestover.

Den 21de August beregnedes Gaarsdagens Observationer og afsattes i Kartet. Capt. Grieg foretog Lodninger i Advent Bay. Om Eftermiddagen maalte jeg Vinkler fra de Signaler, jeg havde opsat den forrige Eftermiddag.

Den 22de fortsatte Capt. Wille Kartarbejdet. Capt. Grieg loddede om Formiddagen, og Capt. Wille om Eftermiddagen. Kl. 6 Eft. lettede vi og sejlede ud Isfjorden.

Kartet over Advent Bay er tegnet af Capt. Wille. Det originale Kart i 1:30000 er gjengivet her i 1:50000. Kartet beror, som af ovenstaaende Beskrivelse vil sees, paa en fuldstændig Triangulation. De trigonometriske Punkter ere paa Kartet merkede med de latinske Bogstaver. Azimutbestemmelsen, der orienterer Kartet, antages sikker paa et Minut, og Længdeudstrækningerne sikre paa en totusindedel af samme. Angaaende den absolute Bredde og Længde henvises til min Afhandling om de astronomiske Observationer Side 19.

Forresten indeholder Kartet selv de nodvendige Oplysninger.

boatswain and a sailor, so as to extend one after the other (I, II, III) from Base B, and as nearly as the eye could determine in the true line. There was a light breeze blowing at right angles to the base line, and the operation could be easily performed by commanding "luff" and "off." When the rods were being moved, I put my foot on the last of them, keeping it there till the next had been placed end on against it, and properly adjusted. In this manner a pretty accurate measurement could be made on the flat ground. By means of the rods and a metre-measure, the whole length of the base line was found to be 299.11 metres. Any appreciable reduction for the inclination of the rods, I have not thought necessary to apply. The metre-measure, which I used as the standard measure of length, had been bought in Paris; it is of wood, furnished with the government stamp, and made to fold up. This instrument is about a millimetre longer than two other metre-scales, of more accurate construction, that we have here. The excess in length may be regarded as compensating the error arising from the inclination and imperfect adjustment of the rods. After measuring the base line, I erected the signals Y, T, and others farther west.

On the 21st of August, the observations taken the day before were computed and laid down on the Map. Capt. Grieg sounded in the Bay. In the afternoon I measured angles from the signals I had erected on the previous day.

On the 22nd, Capt. Wille went on constructing his map. Capt. Grieg took soundings in the forenoon and Capt. Wille in the afternoon. At 6 p.m. we got under weigh, and steamed out of Ice Sound.

For the Map of Advent Bay we are indebted to Capt. Wille. The original map was on a scale of $\frac{1}{30.000}$; the scale of that annexed to this Memoir is $\frac{1}{50.000}$. As will appear from the above description, the Map of Advent Bay is based on a complete triangulation. The trigonometrical points are denoted by capital letters. The azimuth determination, on which is based the direction of the meridian of the Map, may be regarded as true to a minute, and the longitudinal extent as correct within the two-thousandth part of the actual length. As regards the absolute latitude and longitude, the reader is referred to my "Astronomical Observations," page 19.

For the rest, all necessary information is given in the Map.

Billederne, Fig. 1—9, ere tegnede af Landskabsmaler *Carl Nielsen*, efter Skitser tagne paa Stedet af Hr. F. W. Schiertz, Prof. G. O. Sars og Prof. H. Mohn.

Figs. 1 to 9 are drawn by *Carl Nielsen*, artist, from sketches taken on the spot by F. W. Schiertz, artist to the Expedition, Prof. G. O. Sars, and Prof. H. Mohn.

Translated into English by **John Hazeland.**

Tegnet af F. W. Schiertz. Lith. af F. Larsen.

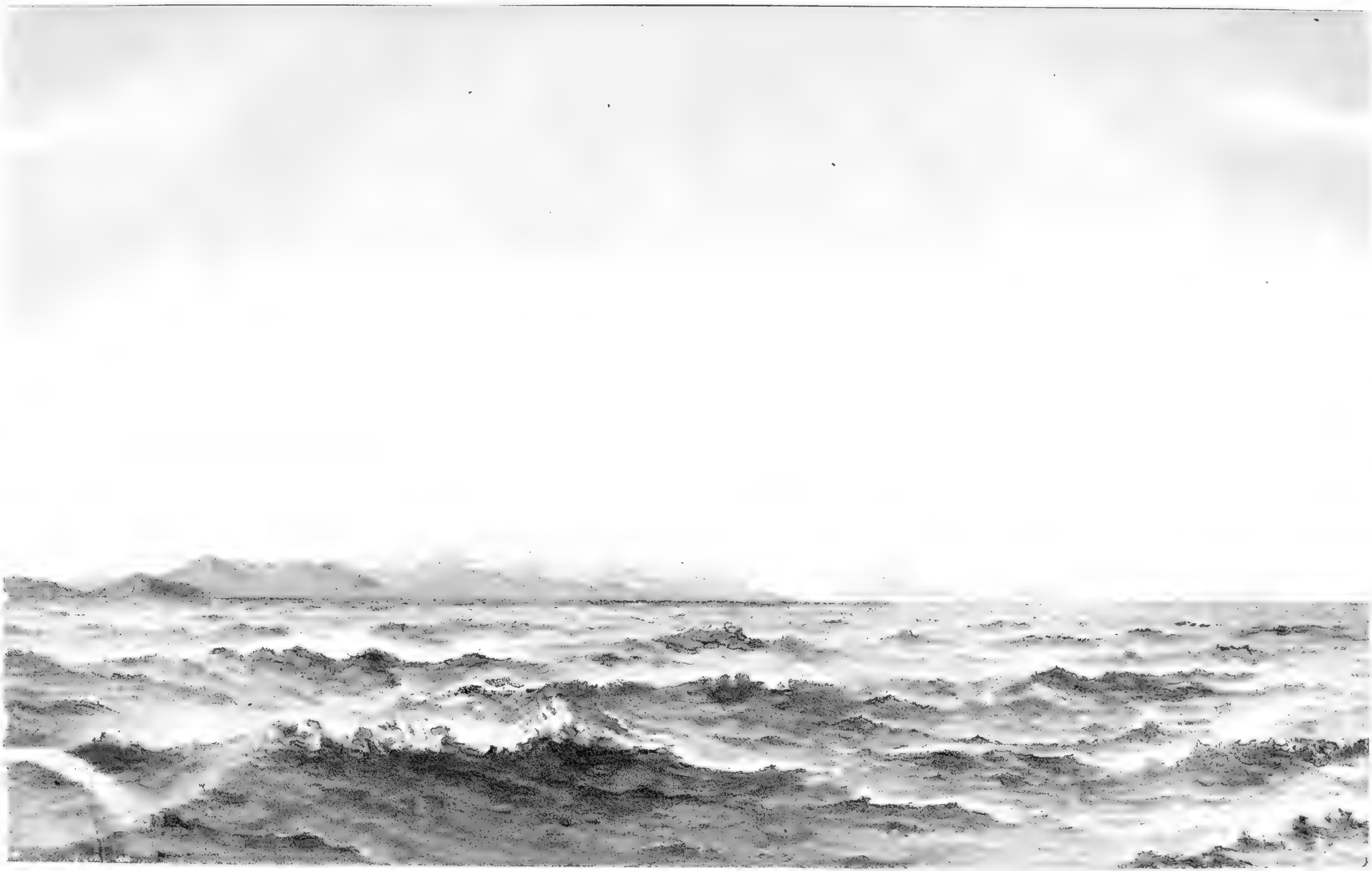
Hoffensberg & Trap's Etabl. Kjøbenhavn

FRA VESTMANNA-ÖERNE. ISLAND.

Tegnet af F. W. Schiertz Lith. af F. Larsen.

Hoffensberg & Trap's Etabl. Kjøbenhavn

LAGUNEN PAA ÖSTSIDEN AF JAN MAYEN.



Tegnet af H. Mohn. Lith af F. Larsen

Hoffensberg & Traps Etabl. Kjøbenhavn

BEERENBERG. JAN MAYEN.

Tegnet af F.W. Schiertz. Lith. af F. Larsen.

Hoffensberg & Trap^{s} Etabl. Kjöbenhavn.

ÖSTSIDEN AF BEEREN-EILAND.

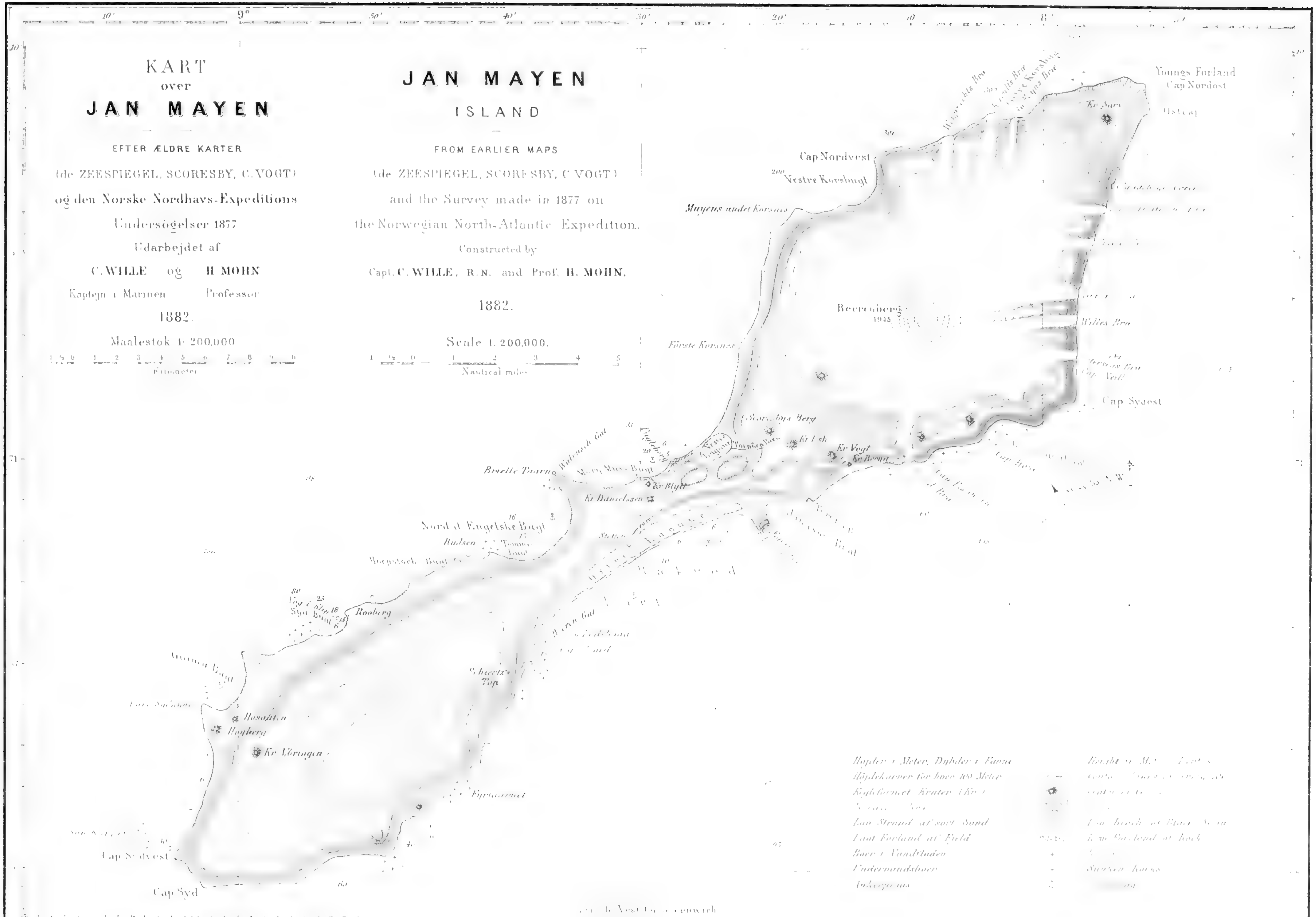
Tegnet af F.W. Schiertz Lith. af F. Larsen. Hoffensberg & Trap's Etabl. Kjøbenhavn

SYDKAP. SPIDSBERGEN.

Tegnet af F.W. Schiertz. Lith af F. Larsen.

Hoffensberg & Trap's Etabl. Kjøbenhavn

MAGDALENE-BAI. SPIDSBERGEN.


KART
over
JAN MAYEN
EFTER ÆLDRE KARTER
(de ZEESPIEGEL, SCORESBY, C. VOGT)
og den Norske Nordhavs-Expeditions
Undersögelser 1877
Udarbejdet af
C. WILLE og H. MOHN
Kaptejn i Marinen Professor
1882.
Maalestok 1: 200,000
Kilometer
JAN MAYEN
ISLAND
FROM EARLIER MAPS
(de ZEESPIEGEL, SCORESBY, C. VOGT)
and the Survey made in 1877 on
the Norwegian North-Atlantic Expedition.
Constructed by
Capt. C. WILLE, R.N. and Prof. H. MOHN.
1882.
Scale 1: 200,000.
Nautical miles
Youngs Forland
Cap Nordost
Kr. Sars
Cap Nordvest
Vestre Korsbugt
Mayens andet Korsnæs
Beerenberg
1945
Wiltes Bræ
Cap Vogt
Cap Sydøst
Förste Korsnæs
Kr. Vogt
Kr. Brenna
Kr. Blyth
Kr. Danielsen
Brielle Taarne
Nord il Engelske Bugt
Rudsen
Rooberg
Hoyberg
Kr. Vörtingen
Cap Sydvest
Cap Syd
Schiertz's Top
Eyrmannet
Höjder i Meter; Dybder i Favne
Höjdekurver for hver 100 Meter
Keglformet Krater (Kr.)
Lav Strand af sort Sand
Lavt Forland af Field
Baer i Vandfladen
Undervandsbaer
Isbergene

KART over ADVENT BAY
i Isfjorden paa Spidsbergen.
optaget af Kaptejn i Marinen C. F. Wille
med Assistance af
Professor Dr. H. Mohn og Skibskaptein J. Grieg, 1878.

Punkt A ligger paa { *78° 14' 48" Nord Bredde* / *15° 34' 14" Længde Öst Gr*

Azimuth af Linien A C er 3° 15,'5 S. ad Ö

Kompassets Misvisning 1878 = 12°,25 vestlig

Lodskud i Favne.

ADVENT BAY
Spitzbergen; Icefjord.
Surveyed by Capt. C. F. Wille R. N.
with the assistance of
Prof. H. Mohn and Capt. J. Grieg. 1878

Point A { *78° 14' 48" Nth Lat* / *15° 34' 14" Long. E. Gr.*

Azimuth of line A C = S 3° 15,'5 E.

Variation in 1878 = 12°,25 West

Soundings in fathoms

Maalestok 1: 50,000

0 5 10 Kabl
0 1 2 3 4 Kvartmil (Naut miles)

DEN NORSKE NORDHAVS-EXPEDITION

1876—1878.

CHEMI.

I. OM LUFTEN I SØVANDET.
II. OM KULSYREN I SØVANDET.
III. OM SALTHOLDIGHEDEN AF VANDET
I DET NORSKE NORDHAV.

AF

HERCULES TORNØE.

MED 3 TRÆSNIT OG 3 KARTER.

CHRISTIANIA.
GRØNDAHL & SØNS BOGTRYKKERI.
1880.

THE NORWEGIAN NORTH-ATLANTIC EXPEDITION

1876—1878.

CHEMISTRY.

I. ON THE AIR IN SEA-WATER.
II. ON THE CARBONIC ACID IN SEA-WATER.
III. ON THE AMOUNT OF SALT IN THE WATER OF THE NORWEGIAN SEA.

BY

HERCULES TORNØE.

WITH 3 WOODCUTS AND 3 MAPS.

CHRISTIANIA.
PRINTED BY GRØNDAHL & SØN.
1880.

ser paa Reiser at give Bidrag til Løsningen af Spørgsmaalet om Fordelingen af Luften i Havet, da har Anledningen dertil næsten bestandig manglet. Først ved de i de senere Tider hyppigt udsendte Expeditioner, hvormed der har været givet Chemikere Anledning til at medfølge, har det været muligt mere detailleret at studere disse Ting. Ved disse Expeditioner har Formaalet udelukkende været videnskabelig Undersøgelse af Havet, og der har derfor med Hensyn paa Udrustningen altid været lagt megen Vind paa ved hensigtsmæssige Foranstaltninger og omhyggelige Forberedelser at fremme dette Formaal saa meget som muligt, og det er derfor klart, at disse Expeditioner maa have den største Betydning for den chemiske Undersøgelse af Havene specielt, hvor Talen er om saadanne Observationer, der ligesom Bestemmelser af Gasarterne ikke taale Opsættelse, men nødvendigvis maa udføres øieblikkelig efter at Vandprøven er øst. Saaledes maa aabenbart de under disse Omstændigheder udførte Observationer faa størst Vægt, hvor det dreier sig om at skaffe Oplysninger om Gasarterne i Søvandet, udenat det dog derfor vil findes paa urette Plads her at give en kort Oversigt ogsaa over de herover udførte ældre Undersøgelser.

De tidligste Undersøgelser, der mig bekjendt ere gjorte over Luften i Søvandet, udførtes i 1838 af Frémy[1] paa nogle Vandprøver, der over et Aar forud vare blevne optagne paa den franske Expedition med 'La Bonite' i 1836 og 37. Vandprøverne bestode dels af Overfladevand dels af Vand fra forskjellige Dyb indtil 450 franske Favne og vare optagne med et af Biot opfundet Apparat.[2]

Ved Analysen af den udkogte Gas absorberede Frémy Kulsyren med Kalilud og Surstoffet med Phosphor. Resultaterne ansaaes allerede af Frémy selv for upaalidelige og de staa saa bestemt i Strid med alle nyere Angivelser, at man med temmelig stor Sikkerhed kan antage, at det lange Tidsrum mellem Vandprøvernes Øsning og deres Undersøgelse har gjort dem fuldstændig ubrugbare.

I 1843 udførte Morren[3] nogle Undersøgelser af Overfladevandet ved Saint-Malo nærmest i den Hensigt at paavise Sollysets Indflydelse paa den relative Sammensætning af den af Vandet absorberede Luft. Han kom i den Henseende til det Resultat, at Surstofmængden fandtes størst og Kulsyremængden mindst ved klart Sollys, hvorimod omvendt Surstofmængden fandtes mindst og Kulsyremængden størst ved mørkt overskyet Veir. Vandprøverne undersøgtes ikke paa Stedet, men sendtes til Rennes, hvor de af Morren udkogtes i Kolber paa 4.5 Litre. Den udkogte Gas ledede gjennem Kautschukledning over i en Flaske, hvori Gasarterne opsamledes over Vand. Ved Analysen af Gasen anvendte han til Absorbtion af Kulsyren Kalilud og for-

[1] Compt. rend. 6 — 616.
[2] Pogg. Ann. 37 — 416.
[3] Ann. Chim. Phys. [3, — 12 — 5.

riably lacked the means. Not till chemists had been sent out on the numerous Expeditions dispatched of late years to all quarters of the globe, was it possible to study this subject in detail. The sole object of such Expeditions having been the scientific investigation of the ocean, they were naturally fitted out with the greatest possible care, being furnished with the latest and most improved apparatus, and every necessary aid and appliance. It is obvious, therefore, that these Expeditions must largely contribute to our chemical knowledge of the ocean, more particularly with regard to observations which, like the determination of gaseous bodies, will not brook delay, but must be taken immediately the sample of water has been drawn. Hence, very great weight should be attached to observations instituted under such circumstances, viz. those that relate to the determination of gaseous bodies in sea-water. It will not, however, be out of place, briefly to notice some of the earlier observations undertaken with that object in view.

The earliest experiments, so far as I am aware, relating to the air in sea-water, were instituted in 1838, by Frémy,[1] with samples of water drawn more than a year before on the French Expedition with the 'Bonite,' in 1836 and 1837. These samples of water consisted partly of surface-water, partly of water from various depths, the greatest being 450 French fathoms; and were collected with an apparatus devised by Biot.[2]

When analysing the gas driven off, the carbonic acid was absorbed in a lye of potash, the oxygen being consumed with phosphorus. But Frémy himself did not regard as trustworthy the results of this process; and they have proved so decidedly at variance with those of all later observations, that his samples of water, owing to the length of time for which they had been preserved previous to examination, had no doubt become utterly worthless for experimental purposes.

In 1843, Morren[3] instituted a series of experiments with surface-water, near St. Malo, chiefly with the object of determining the influence of solar light on the composition of the air absorbed by sea-water. He found the proportion of oxygen to be greatest, and that of carbonic acid least, in bright weather; whereas the proportion of oxygen was least, and that of carbonic acid greatest, with a dark, cloudy sky. The samples of water were not examined on the spot, but taken to Rennes, and there boiled by Morren, in matrasses containing 4.5 litre. The gas driven off during the process was conducted through a caoutchouc tube into a phial, and there collected over water. When analysing, the gas, Morren used a lye of

[1] Compt. rend. 6, p. 616.
[2] Pogg. Ann. 37, p. 416.
[3] Ann. Chim. Phys. [3], 12, p. 5.

brændte Surstofgasen med overskydende Vandstof. Han brugte ogsaa her som Spærrevædske Vand, som paa Forhaand var mættet med Luft, og det kan saaledes ikke forundre, at de Resultater, han erholdt, vise temmelig betydelige Afvigelser. Surstofmængden varierer saaledes fra 39.5 til 31.0 og udgjør i Middel 34.7 % af den samlede Surstof-Kvælstofmængde, medens denne varierer mellem 20.0 og 30.5 og i Middel udgjør 24.5 CC. pr. Litre af det udkogte Vand. Som man heraf ser, svarer den midlere Surstofprocent meget nøie med det af Bunsen senere for destilleret Vand opstillede Tal, hvorimod de Tal, Morren opfører som Udtryk for den samlede Surstof-Kvælstofmængde, ingen nøiagtig fixeret Betydning have, da han intetsteds angiver den Barometerstand og Temperatur, hvortil han har reduceret sine Gasvolumina.

Nogle Aar senere i 1846 gjenoptog Lewy[1] Morrens Undersøgelser paa nogle Vandprøver, som han øste ved Langrune i Nordost for Saint-Malo, og anvendte for at kunne sammenligne sine Resultater med Morrens nøiagtig den af ham beskrevne Arbeidsmethode. Hans Resultater vise ogsaa, naar man tager Hensyn til, at Vandprøverne alle skrive sig fra samme Sted, ikke ubetydelige om end meget mindre Afvigelser, som han ligesom Morren tilskriver Sollysets Indflydelse. Surstofmængden varier hos ham fra 35.4 til 32.4 og udgjør i Middel 33.6 % af den samlede Surstof-Kvælstofmængde, som gjennemsnitlig beløber sig til 17.3 CC. pr. Litre og ikke overskrider Grændserne 18.9 og 16.3. Heller ikke Lewy har nærmere fixeret Betydningen af de opførte Gasvolumina. Der har forresten i hans Tabel indsneget sig meningsforvirrende Regnefeil, som har givet Anledning til, at han er bleven misforstaaet.

I 1851 har endvidere A. Hayes[2] offentliggjort nogle Udtalelser om Fordelingen af Luften i Søvandet dog uden at vedføie sine Originalobservationer. Ifølge ham findes i Vand fra større Dyb altid en betragtelig mindre Mængde Surstof end i Overfladevandet, en Regel, som overalt holdt stik saavel i den hede som tempererede Zone, naar undtages i Golfstrømmen, hvor den stærke Bevægelse i Vandet kunde antages at forstyrre den almindelige Ligevægt. Han fandt ogsaa efter Storme en betydelig større Surstofmængde i Overfladevandet.

I 1855 udførte M. F. Pisani[3] nogle Undersøgelser af Saltene i Overfladevandet ved Bujuk-Déré og bestemte samtidig de i Vandet indeholdte Gasarter. Resultaterne findes sammenstillede i nedenstaaende Tabel, hvor Volumet er reduceret til 0° og 766^{mm} Tryk og udtrykt som CC. pr. Litre Vand.

[1] Ann. Chim. Phys. [3] — 17. Ann. Chem. Pharm. 58 — 326.
[2] Sillim. Amer. Journ. [2] — 11 — 241.
[3] Compt. rend. 41 — 532.

potash for absorbing the carbonic acid, and consumed the oxygen with a surplus of hydrogen. Here, too, the confining fluid was water, previously saturated with air; and hence it is not surprising, that the results obtained should have been found to vary considerably. Thus, for instance, the amount of oxygen varies between 39.5 and and 31.0 per cent, the mean proportion being 34.7 of the total amount of oxygen and nitrogen; while the latter ranges from 20.0 to 30.5, giving a mean proportion of 24.5^{cc} per litre. The mean percentage of oxygen agrees, therefore, very closely with the proportion afterwards found by Bunsen for distilled water; whereas no definite importance can be attached to Morren's figures representing the total amount of oxygen and nitrogen, since that observer does not anywhere state to what temperature and atmospheric pressure he had reduced the volume of the gas.

Some years after, in 1846, Lewy[1] repeated Morren's experiments, with samples of water drawn at Langrune, north-east of Saint-Malo, adopting, the better to compare his results with those of Morren, precisely the same mode of operation. The results obtained by this chemist, seeing that the samples of water were all of them from the same locality, vary, too, considerably, though by no means to the same extent, — which he, in common with Morren, ascribes to the influence of solar light. The amount of oxygen ranges from 35.4 to 32.4—33.6 per cent, being the mean proportion of the total amount of oxygen and nitrogen, which averages 17.3^{cc} per litre, having in no case passed the limits 18.9 and 16.3. Lewy, too, omits to give the factors determining the volume of the gas. Moreover, divers perplexing errors have slipped into his Table; and hence he has been misunderstood by some.

In 1851, A. Hayes[2] published a paper on the distribution of air in sea-water, without however embodying his original observations. According to the observations of that chemist, the amount of oxygen in water drawn from great depths is always appreciably less than that in surface-water, a rule which holds good for all seas both of the torrid and the temperate zones, with the exception of the Gulf Stream, where the strong current may be supposed to exert a disturbing influence. After a heavy gale of wind, too, the proportion of oxygen in the surface-water was found to be much greater.

In 1855, M. F. Pisani[3] instituted a series of observations near Bujuk-Déré on the salts in surface-water, and also determined the gaseous bodies it contained. His results are given in the following Table, the volume being reduced to a temperature of 0° and a pressure of 760^{mm}, expressed in cubic centimetres per litre.

[1] Ann. Chim. Phys. [3], 17; Ann. Chem. Pharm. 58, p. 326.
[2] Sillim. Amer. Journ. [2], 11, p. 241.
[3] Compt. rend. 41, p. 532.

$O + N$ pr. Litre		16.0	16.2
$O + N = 100$	O %	31.4	33.2
	N %	68.5	66.8

I Aaret 1869 udgik fra England Porcupineexpeditionen, hvor der for første Gang foruden de øvrige videnskabelige Arbeider ogsaa foresloges udført mere omfattende chemiske Undersøgelser. Man besluttede her at benytte den udmærkede Anledning til ved talrige Forsøg saavel med Overfladevand som Vand fra større Dyb at skaffe sig Oplysning om de Fluctuationer, som optræde saavel i de absolute som relative Mængder af de i Søvandet opløste Gasarter. Forat undgaa de Feil, som nødvendigvis maatte indsnige sig, naar de til Gasanalyser bestemte Vandprøver opbevaredes i længere Tid før Undersøgelsen, bestemte man sig her for den Udvei at foretage Gasanalyserne ombord. Til Optagelse af de fra større Dyb stammende Vandprøver benyttedes en meget simpel Vandhenter bestaaende af en hul Metalcylinder med letbevægelige opadslaaende Kegleventiler, et Apparat, hvis Paalidelighed senere Undersøgelser giver Anledning til at betvivle. Udkogningen og Opsamlingen af Gasarterne foretoges i alt Væsentligt som ved de tidligere beskrevne Forsøg, og anvendtes under Analysen til Absorbtion af Kulsyre og Surstof Kalihydrat og pyrogallussur Kali. Det siger sig selv, at de paa denne Maade erholdte Resultater maatte være beheftede med meget betydelige Observationsfeil, hvad der ogsaa tydeligst vises af de store Afvigelser mellem de af forskjellige Observatorer efter denne Fremgangsmaade udførte Bestemmelser. Som Udtryk for Sammensætningen af den af Overfladevandet udkogte Luft fandt nemlig de tre Chemikere, som paa de tre Togter, hvori denne Expedition deltes, efter hinanden udførte de chemiske Arbeider, følgende Tal:[1]

W. L. Carpenter	31.6 % O	mod	68.4 %	N.
Hunter	36.4 - O	-	63.6 -	N.
P. Herbert Carpenter	30.5 - O	-	69.5 -	N.

Dette er kun de af de enkelte Observationer udledede Middelværdier, men, som man ser, er allerede Afvigelserne mellem disse overmaade store, medens de enkelte Bestemmelser, som ikke findes opførte, varierer mellem langt videre Grændser. Saaledes opføres som Ydergrændser for Variationerne af Surstofmængden i Overfladevandet Maximum 45.3 og Minimum 14.0 % af den samlede Gasmængde, Kulsyren iberegnet.

Porcupineexpeditionens Chemikere ansaa selv sine Resultater upaalidelige, dog mindre paa Grund af Mangler ved Arbeidsmethoderne, end fordi den af dem benyttede Vandhenter tillod Undvigelsen af den Luft, som de mente kunde udvikle sig, naar Vandet fra de større Dyb naaede op til det ved Overfladen herskende mindre Tryk. De tog forresten sin Tilflugt ogsaa til andre Midler for at forklare

[1] Proc. Roy. Soc. 18 — 397.

$O + N$ pr. Litre		16.0	16.2
$O + N = 100$	O p.ct.	31.4	33.2
	N p.ct.	68.5	66.8

In the year 1869, the 'Porcupine' Expedition was dispatched by the British Government, and it was now proposed, for the first time, to institute a series of chemical experiments on a more comprehensive scale than any hitherto performed. By taking advantage of this excellent opportunity to examine numerous samples of sea-water, both from the surface and from great depths, the fluctuations that occur alike in the absolute and the relative amounts of gaseous bodies in ocean-water might be effectively investigated. In order to guard against the error that must necessarily arise when the samples of water are preserved for any length of time previous to examination, it was resolved to undertake all analyses of gas on board. For obtaining samples of water from great depths, a very simple instrument was used, consisting of a hollow metal cylinder, furnished with conical-shaped valves, opening above, an apparatus the trustworthiness of which subsequent experiments have shown reason to doubt. The gas was boiled out and collected by a process essentially similar to that adopted for the experiments previously described, the carbonic acid and the oxygen having been absorbed by hydrate of potash and pyrogallic acid. As a matter of course, very considerable errors of observation would attach to results obtained by this method, the best proof of which lies in the extent to which the determinations of different observers performed by this mode of operation are found to vary. For instance, the three chemists who successively accompanied the Expedition on the three voyages into which it was divided, express the composition of the air boiled out of surface-water by the following figures:[1] —

W. L. Carpenter	31.6 p.ct. O	and	68.4 p.ct.	N.
Hunter	36.4 - O	-	63.6 -	N.
P. Herbert Carpenter	30.5 - O	-	69.5 -	N.

These amounts, however, are the mean values deduced from the several observations, and yet they vary exceedingly; the individual determinations, which are not given, must obviously have ranged between far wider limits. Thus, the extreme limits between which the amount of oxygen was found to vary in surface-water, is stated to have been 45.3 (maximum) and 14.0 (minimum) per cent of the total amount of gas, including the carbonic acid.

The chemists who accompained the 'Porcupine' Expedition did not even themselves regard the results obtained as trustworthy, less however on the ground of possible defects in the modes of operation, than because the the apparatus used for collecting the water admits of the escape of air which, in their opinion, may be liberated on water drawn from great depths reaching the surface, where the atmos-

[1] Proc. Roy. Soc. 18, p. 397.

de observerede store Afvigelser, saaledes tilskreves stærke Bevægelser af Havoverfladen enten ved Storme eller paa anden Maade den Evne at forøge Surstofmængden og formindske Kulsyremængden, ligesom rigt Dyreliv ogsaa tilskreves en meget stor Indflydelse paa Sammensætningen af den i Søvandet opløste Luft.

I 1871 udgik atter igjen denne Gang fra Tyskland en Expedition til Undersøgelse af Østersøen, hvormed som Chemiker fulgte Dr. O. Jacobsen. Med Resultaterne af de fra de tidligere Expeditioner hidrørende Gasbestemmelser for Øie besluttede han sig hverken for den ene eller den anden af de ved Bonite eller Porcupineexpeditionen anvendte Fremgangsmaader men slog ind paa en Middelvei, den eneste, som i dette Tilfælde kunde føre til paalidelige Resultater.

Han delte Undersøgelserne i to Dele og udførte den uopsættelige Del af dem nemlig Gasarternes Udkogning strax, medens han, indseende Umuligheden af at udføre tilfredsstillende Gasanalyser ombord paa et Fartøi i aaben Sø, opsatte deres nærmere Undersøgelse til Hjemkomsten. Desværre gav Mangelen af en til Optagelse af Dybvandsprøver egnet paalidelig Vandhenter Anledning til, at det 1ste Aars Udbytte af denne Expedition for Gasanalysernes Vedkommende reducerede sig til blot og bart Indsamling af den Erfaring, som senere skulde komme til Anvendelse ved det Aaret efter foretagne Togt i Nordsøen. Manglerne ved den paa Porcupineexpeditionen benyttede Vandhenter havde nemlig bevæget Jacobsen til ogsaa til Øsning af de for Gasanalyser bestemte Vandprøver at benytte en Vandhenter, der nedsænkedes fyldt med Luft. Naar nu Apparatet i Dybet aabnedes, absorberedes under det der herskende store Tryk momentant en Del af den nedbragte atmosphæriske Luft, hvorved de paa disse Vandprøver udførte Gasanalyser bleve saa upaalidelige, at der ikke engang værdigedes dem en Offentliggjørelse.

De paa Østersøtogtet i 1871 indhøstede Erfaringer, muliggjorde det imidlertid for Jacobsen ved en omhyggelig Forberedelse til den i 1872 foretagne Expedition i Nordsøen at overvinde eller omgaa de Vanskeligheder, som havde bevirket Manglerne ved de paa Porcupineexpeditionen foretagne Undersøgelser, og det lykkedes ham denne Gang som Resultat af sine Arbeider at offentliggjøre en Afhandling,[1] som giver en Række af vore Tiders Fordringer strengt tilfredsstillende Oplysninger om Luften i Søvandet. Til Optagelse af de til Gasanalyser bestemte Vandprøver fra Dybet tjente paa Nordsøtogtet et af Dr. H. A. Meyer angivet Apparat[2] bestaaende af en tung Metalcylinder, som ved Udløsning i det bestemte Dyb faldt ned over to vel islebne koniske Ventiler, og derved afspærrede det mellem disse

[1] Ann. Chem. Pharm. 167 — 1; Jahresbericht der Commission zur wissenschaftlichen Untersuchung der deutschen Meere in Kiel, 1872—73 — 43.

[2] Jahresbericht der Commission zur wissenschaftlichen Untersuchung der deutschen Meere in Kiel 1872—73 — 5.

pheric pressure is less. But they had recourse to other means whereby to explain the great differences observed, ascribing to the state of violent agitation into which the surface of the ocean is thrown by heavy storms, or to some other adequate cause, the ability of increasing the proportion of oxygen and diminishing that of carbonic acid; an abundance of animal life, too, was believed to exert very great influence on the composition of the air absorbed in sea-water.

In 1871, an Expedition was despatched from Germany for the investigation of the Baltic, Dr. O. Jacobsen accompanying it as chemist. Warned by the unsatisfactory results of former gas-analyses, he resolved to adopt neither of the methods resorted to on the 'Bonite' and 'Porcupine' Expeditions, but rather to take a middle course, which indeed held out the only prospect of success.

Accordingly, he divided his observations. Experiments admitting of no delay, such as boiling off the gas, were performed at once, whereas all analyses of gas, impossible as it is found to operate satisfactorily on board a vessel in the open sea, were deferred till his return home. Unfortunately, the want of a trustworthy apparatus for collecting samples of water from great depths, confined the results obtained on the first voyage of the Expedition, as regards analyses of gas, to the mere acquisition of experience, which, however, there was ample opportunity of applying on the cruise undertaken the following year in the North Sea. The defective construction of the instrument employed for collecting water on the 'Porcupine' Expedition had induced Jacobsen to make use of an apparatus which, even when drawing water for gas-analyses, was sunk full of air. Now, on opening this apparatus at the required depth, some portion of the air it contains will, by reason of the great pressure, be momentarily absorbed; and hence all analyses of gas with such samples of water proved to that extent defective as to be not even deemed worthy of publication.

Meanwhile, taking advantage of the experience acquired in 1871 on the cruise in the Baltic, Dr. Jacobsen succeeded, after careful preparation to meet the requirements of the Expedition undertaken in 1872 to the North Sea, in surmounting or evading the difficulties experienced on the 'Porcupine' Expedition, and was enabled, as the result of his labours, to publish a treatise[1] on the air present in sea-water recording a series of eminently satisfactory results. For collecting samples of water wherewith to undertake analyses of gas in water from the bottom, or from great depths, an apparatus, described by Dr. H. A. Meyer, was made use of on the cruise in the North Sea.[2] It consists of a heavy metal cylinder, which, at the required depth, will drop down on two accurately fitted conical valves, cutting off all com-

[1] Ann. Chem. Pharm. 167, p. 1; Jahresbericht der Commission zur wissenschaftlichen Untersuchung der deutschen Meere in Kiel, 1872—73, p. 43.

[2] Jahresbericht der Commission zur wissenschaftlichen Untersuchung der deutschen Meere in Kiel, 1872—73, p. 5.

beliggende Vandlag. Udløsningen foregik enten ved Apparatets Anslag mod Bunden eller i intermediære Dyb ved et langs Linen nedsænket Lod.

Ved Uddrivelsen af de i Vandet indeholdte Gasarter anvendte Jacobsen Bunsens Princip, idet Vandet kogtes i

munication with the outside water. The detachment was effected either by the instrument striking the bottom, or, at intermediate depths, by running a weight down the line.

For expelling the gas contained in the water, Jacobsen made choice of Bunsen's method, boiling the water in

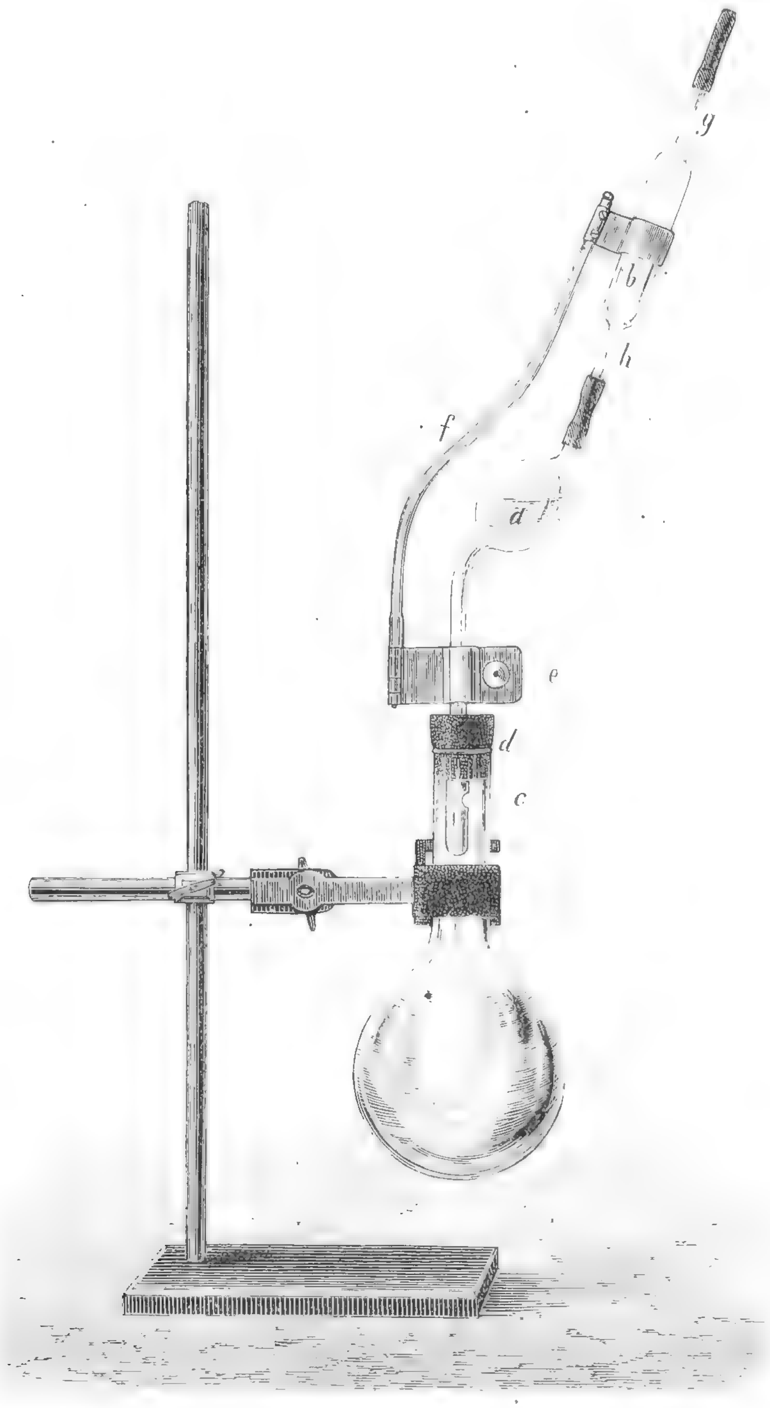


Fig. 1.

et ved Vanddamp frembragt Vacuum, og construerede i Forbindelse med Dr. H. Behrens i dette Øiemed et Apparat, som i Simpelhed og Paalidelighed Intet lader tilbage at ønske. Apparatet, som findes afbildet i Figur 1, har af Jacobsen faaet følgende Beskrivelse:

a vacuum created by steam; and to meet the requirements of this process, he devised, with the assistance of Dr. H. Behrens, an apparatus which in trustworthiness and simplicity of construction leaves nothing to be desired. This apparatus, of which a drawing is given in Fig. 1, Dr. Jacobsen has described as follows: —

"Die Siedekugel *a* läuft in ihrem unteren Theil in ein starkwandiges, genau cylindrisches Glasrohr aus, welches unten zugeschmolzen, aber bei *c* mit einer seitlichen Oeffnung versehen ist. Je nachdem diese Oeffnung bis unter den Kautschukpfropfen *d* hinabgedrückt oder bis in seine Durchbohrung heraufgezogen wird, ist die Siedekugel mit dem Innern des Wasserkolbens in Verbindung oder gegen dasselbe abgeschlossen. Das Glasrohr muss sich in der glatten Durchbohrung des Kautschukpfropfens mit Reibung auf- und niederbewegen, diese Reibung darf aber nicht so stark sein, wie die zwischen dem Pfropfen und dem cylindrischen Kolbenhals. Ist einmal ein fehlerfreier Pfropfen aus vulkanisirtem Kautschuk den Glastheilen des Apparates auf das Sorgfältigste angepasst, so kan diese Ventilvorrichtung unbegrenzt lange benuzt werden, ohne von ihrer völligen Zuverlässigkeit einzubüssen.

Das Gassammelrohr *b* ist durch ein kurzes Kautschukrörchen mit der Siedekugel verbunden und zwischen die federnden Arme des messingenen Halters *f* eingeklemmt. Das untere Ende dieses Halters trägt eine weit stärkere Klammer, deren Korkfütterung durch die starche Schraube *e* sehr fest um das Rohr der Siedekugel gepresst wird, so dass man, am unteren Theil des Halters anfassend, Siedekugel und Sammelrohr in dem Kautschukpfropfen auf- und niederschieben und damit die Oeffnung *c* beliebig verlegen kann.

Der Rauminhalt der Siedekugel beträgt etwas mehr als das Doppelte von dem Volumen, um welches sich die auszukochende Wassermenge beim Erwärmen auf 100° ausdehnt.

Bei der Benutzung des Apparates füllt man zunächst die schon im Pfropfen steckende und in den Halter eingeklemmte Siedekugel zur Hälfte mit Wasser und schiebt den Pfropfen über die seitliche Oeffnung. Man füllt nun die Kochflasche durch ein bis auf ihren Boden reichendes Gummirohr direct aus dem Schöpfapparat bis zum Ueberlaufen mit dem auszukochenden Wasser und setzt, nachdem die Oeffnung *c* bis eben unter den Kautschukpfropfen verschoben ist, diesen sehr fest in den Hals der Kochflasche ein. Zieht man nun die Siedekugel bis zur Herstellung des Verschlusses in die Höhe, so entsteht dadurch in der Kochflasche ein kleines Vacuum, in welches sofort Gasbläschen aus dem Wasser aufsteigen. Es wird dadurch Raum geschafft für die Ausdehnung, welche das oft sehr kalte Wasser schon in den ersten Augenblicken durch die höhere Temperatur der umgebenden Luft erfährt. Man fügt nun das Sammelrohr an, über dessen beide Enden vorher kurze Gummiröhren gezogen sind, stelt die Kochflasche in ein Wasserbad, erhitzt das Wasser in der Siedekugel durch eine darunter angebrachte Weingeistflamme und erhält es im Sieden, bis man der vollständigen Austreibung der Luft aus dem Sammelrohr gewiss sein kann. In dem Augenblick, in welchem man mit der rechten Hand die Flamme entfernt, kneift man mit der linken das Ende des oberen Gummirohrs zu, verschliesst es darauf durch Hineinstecken der abgerundeten Spitze eines passenden Glasstäbchens und schmilzt sofort bei *g* ab.

"Die Siedekugel *a* läuft in ihrem unteren Theil in ein starkwandiges, genau cylindrisches Glasrohr aus, welches unten zugeschmolzen, aber bei *c* mit einer seitlichen Oeffnung versehen ist. Je nachdem diese Oeffnung bis unter den Kautschukpfropfen *d* hinabgedrückt oder bis in seine Durchbohrung heraufgezogen wird, ist die Siedekugel mit dem Innern des Wasserkolbens in Verbindung oder gegen dasselbe abgeschlossen. Das Glasrohr muss sich in der glatten Durchbohrung des Kautschukpfropfens mit Reibung auf- und niederbewegen, diese Reibung darf aber nicht so stark sein, wie die zwischen dem Pfropfen und dem cylindrischen Kolbenhals. Ist einmal ein fehlerfreier Pfropfen aus vulkanisirtem Kautschuk den Glastheilen des Apparates auf das Sorgfältigste angepasst, so kan diese Ventilvorrichtung unbegrenzt lange benutzt werden, ohne von ihrer völligen Zuverlässigkeit einzubüssen.

Das Gassammelrohr *b* ist durch ein kurzes Kautschukröhrchen mit der Siedekugel verbunden und zwischen die federnden Arme des messingenen Halters *f* eingeklemmt. Das untere Ende dieses Halters trägt eine weit stärkere Klammer, deren Korkfütterung durch die starke Schraube *e* sehr fest um das Rohr der Siedekugel gepresst wird, so dass man, am untern Theil des Halters anfassend, Siedekugel und Sammelrohr in dem Kautschukpfropfen auf- und niederschieben und damit die Oeffnung *c* beliebig verlegen kann.

Der Rauminhalt der Siedekugel beträgt etwas mehr als das Doppelte von dem Volumen, um welches sich die auszukochende Wassermenge beim Erwärmen auf 100° ausdehnt.

Bei der Benutzung des Apparates füllt man zunächst die schon im Pfropfen steckende und in den Halter eingeklemmte Siedekugel zur Hälfte mit Wasser und schiebt den Pfropfen über die seitliche Oeffnung. Man füllt nun die Kochflasche durch ein bis auf ihren Boden reichendes Gummirohr direct aus dem Schöpfapparat bis zum Ueberlaufen mit dem auszukochenden Wasser und setzt, nachdem die Oeffnung *c* bis eben unter den Kautschukpfropfen verschoben ist, diesen sehr fest in den Hals der Kochflasche ein. Zieht man nun die Siedekugel bis zur Herstellung des Verschlusses in die Höhe, so entsteht dadurch in der Kochflasche ein kleines Vacuum, in welches sofort Gasbläschen aus dem Wasser aufsteigen. Es wird dadurch Raum geschafft für die Ausdehnung, welche das oft sehr kalte Wasser schon in den ersten Augenblicken durch die höhere Temperatur der umgebenden Luft erfährt. Man fügt nun das Sammelrohr an, über dessen beide Enden vorher kurze Gummiröhren gezogen sind, stellt die Kochflasche in ein Wasserbad, erhitzt das Wasser in der Siedekugel durch eine darunter angebrachte Weingeistflamme und erhält es im Sieden, bis man der vollständigen Austreibung der Luft aus dem Sammelrohr gewiss sein kann. In dem Augenblick, in welchem man mit der rechten Hand die Flamme entfernt, kneift man mit der linken das Ende des oberen Gummirohrs zu, verschliesst es darauf durch Hineinstecken der abgerundeten Spitze eines passenden Glasstäbchens und schmilzt sofort bei *g* ab.

Nachdem nun die Oeffnung c bis eben unter den Pfropfen hinabgeschoben ist, wird das Wasserbad erwärmt und der Inhalt des Kolbens in heftigem Sieden erhalten. Nach einiger Zeit hat sich im oberen Theil des Kolbenhalses ein freier Raum gebildet, in welchen die Dampfblasen mit Geräusch hineinschlagen. Man bringt durch Entfernen der Wärmequelle oder durch kurzes Herausheben des Apparates aus dem Wasserbade das Wasser aus der Siedekugel in den Kolben zurück und wiederholt dieses Ervärmen und theilweise Abkühlen des Kolbenhalses noch zweimal, wodurch binnen verhältnissmässig kurzer Zeit eine sehr vollständige Austreibung der Luft bewirkt wird.

Es ist sehr leicht, schliesslich das Wasser bis zur vollständigen Anfüllung der Siedekugel steigen zu lassen, worauf man durch Aufziehen derselben den Verschluss herstellt und das Sammelrohr nun auch bei h abschmilzt.

Das Sammeln der Gase mittelst dieses Apparates machte auch bei ziemlich stark bewegter See keine Schwierigkeit.

Gewöhnlich wurden 900 CC Wasser zur Auskochung verwendet."

Ved Hjælp af dette Apparat indsmeltede Jacobsen paa Nordsøtogtet 73 Luftprøver, som efter Hjemkomsten analyseredes efter Bunsens Methode, idet Kulsyren fjernedes med Kali og Surstoffet bestemtes ved Forbrænding med overskydende Vandstof. Han sammenstiller sine Resultater i en Tabel, hvor han i Modsætning til de tidligere Forfattere betragter den kulsyrefrie Luft og Kulsyren hver for sig,[1] saaledes beregnes Surstof og Kvælstofmængderne som Procenter af den kulsyrefrie Luft, der opføres som CC pr. Litre udkogt Vand reduceret til 0^0 og 760^{mm} Tryk. Ifølge denne Tabel hersker der en ganske mærkelig gjennemført Ensartethed i Sammensætningen af den Luft, der er uddrevet af de Vandprøver, som have befundet sig under samme physikalske Forholde, saaledes ligger Surstofprocenten i alle de 24 Luftprøver, som stamme fra Overfladevandet, tiltrods for at de skrive sig fra meget forskjellige Localiteter, mellem de meget snævre Grændser af 34.14 og 33.64, og naar denne Overensstemmelse ikke i samme Udstrækning er fundet at gaa igjen i de dybere Lag, da har dette sin Forklaring i en ujevn Circulation. Naar Surstofmængden overalt i Dybet er funden lig eller noget mindre end i Overfladen, da kan det vel ikke være tvivlsomt, at dette skriver sig fra Surstoffets Forbrug til Oxydation af de i Søvandet forekommende organiske Plante- og Dyrerester samt til Sødyrenes Aandeproces, saaledes som det af Jacobsen udtales med følgende Ord: "Der Zusammenhang dieses Unterschiedes ist leicht zu deuten. In dem schwereren Wasser, welches ohne erhebliche Beimischung aus höhe-

[1] Naar jeg her overalt har anvendt denne Jacobsens Fremstillingsmaade og ifølge denne omregnet de ældre Forfatteres Opgaver, hvor Gasmængderne overalt ere fremstillede som Procenter af den samlede Surstof-Kvælstof-Kulsyremængde, da vil Grunden hertil fremgaa af min senere Afhandling "Om Kulsyren i Søvandet."

Nachdem nun die Oeffnung c bis eben unter den Pfropfen hinabgeschoben ist, wird das Wasserbad erwärmt und der Einhalt des Kolbens in heftigem Sieden erhalten. Nach einiger Zeit hat sich im oberen Theil des Kolbenhalses ein freier Raum gebildet, in welchen die Dampfblasen mit Geräusch hineinschlagen. Man bringt durch Entfernen der Wärmequelle oder durch kurzes Herausheben des Apparates aus dem Wasserbade das Wasser aus der Siedekugel in den Kolben zurück und wiederholt dieses Erwärmen und theilweise Abkühlen des Kolbenhalses noch zweimal, wodurch binnen verhältnissmässig kurzer Zeit eine sehr vollständige Austreibung der Luft bewirkt wird.

Es ist sehr leicht, schliesslich das Wasser bis zur vollständigen Anfüllung der Siedekugel steigen zu lassen, worauf man durch Aufziehen derselben den Verschluss herstellt und das Sammelrohr nun auch bei h abschmilzt.

Das Sammeln der Gase mittelst dieses Apparates machte auch bei ziemlich stark bewegter See keine Schwierigkeit.

Gewöhnlich wurden 900 CC. Wasser zur Auskochung verwendet."

With this apparatus Jacobsen collected on the cruise in the North Sea 73 samples of air, which, after the return of the Expedition, were analysed by Bunsen's method, potash being used for absorbing the carbonic acid, and the oxygen consumed with a surplus of hydrogen. His results are set forth in a Table, where, reversing the custom of earlier authors, he refers separately to the carbonic acid and the air free from that body;[1] thus, for instance, the respective amounts of oxygen and nitrogen will be found computed as percentages of the air free from carbonic acid, which is given in cc. per litre of the water examined, reduced to a temperature of 0^0 and a pressure of 760^{mm}. According to this Table, a truly remarkable uniformity prevails in the composition of the air expelled from samples of sea-water which have been exposed to the same physical influences; thus, for instance, the percentage of oxygen in the 24 samples of air derived from surface-water, was found, notwithstanding the collection of the latter in widely different localities, to range between the exceedingly narrow limits of 34.14 and 33.64; and though equal agreement does not extend to the deeper-lying strata, this may be accounted for by irregularity of circulation. That the amount of oxygen at the bottom, or in great depths, should invariably prove equal to, or somewhat less than, that at the surface, is a phenomenon the cause of which must unquestionably be ascribed to the consumption of that gas in the oxidation of organic remains, and for the support of the res-

[1] The reason that induced me to adopt exclusively Jacobsen's mode of representation, and by the standard of that process to recompute the results of earlier observers, who invariably give the proportions of the gases determined as percentages of the total amount of oxygen, nitrogen, and carbonic acid, will appear in my next Memoir on the carbonic acid present in sea-water.

ren Schichten sehr lange in der Tiefe verweilt, wird ohne genügenden Ersatz fortwährend Sauerstoff verbraucht zur Oxydation der im Wasser und besonders am Meeresgrunde vorhandenen oxydirbaren Stoffe, — in wahrscheinlich weit untergeordnetem Grade auch durch die Athmung der Thiere."

Men de herved foranledigede Afvigelser ere ikke meget store, idet Surstofprocenten, bortseet fra nogle faa Undtagelser, ligger indesluttet mellem 30 og 34, saaledes at den som Regel aftager med Dybet.

Jacobsens Observationer, der vare udforte under de mest forskjelligartede Omstændigheder, vise ogsaa paa det Bestemteste, at de tidligere gjorte Antagelser, om at Sollyset og Stormene eller i det Hele taget de meteorologiske Forholde skulde spille nogen fremtrædende Rolle ligeoverfor den relative Sammensætning af Overfladevandsluften, vare fuldstændig ubegrundede, i ethvert Fald vise de store Overensstemmelser, at disse Factorers Indflydelse maatte være meget ringe.

Med Hensyn paa den absolute Mængde af den Luft, der indeholdes i de fra forskjellige Dyb optagne Vandprøver, da viser den sig at tiltage med Dybet, noget der imidlertid let lader sig forklare ved Temperaturens Aftagen med Dybet, uden at det er fornodent at tage sin Tilflugt til de store Tryk. Der blev ogsaa paa Pomeraniaexpeditionen for at bevise Urigtigheden af den tidligere paa flere Steder udtalte Formodning, om at Luftgehalten i de store Dyb skulde staa i Forhold til det der herskende større Tryk, foretaget specielle Experimenter med en af Dr. Behrens og Jacobsen construeret Vandhenter af Kautschuk. Denne sammenklemtes først mest muligt, hvorpaa den sidste Rest Luft uddreves af den ved Hjælp af Kviksølv, og nedsænkedes derefter fuldstændig lufttom og lufttæt igjenlukket. Først i Dybet ved Apparatets Anslag mod Bund aabnedes det, udspændtes og fyldtes med Vand, hvorpaa det atter lufttæt igjenlukket og fyldt med Vand ankom til Overfladen. Det viste sig altid, at de med dette Apparat optagne Vandprover ikke indeholdt mere Luft, end de ved Vandprøvens Temperatur kunde holde oplost under almindeligt Atmosphæretryk. At dette maatte være saa, kunde man allerede være berettiget til at slutte af nogle Forsøg, som Aimé[1] i 1843 udførte. Han anvendte et i den ene Ende aabent Glasrør, som nedsænkedes fyldt med Kviksølv og i det bestemte Dyb vendtes omkring, hvorved Kviksølvet i Glasrøret delvis erstattedes af Vand paa en saadan Maade, at dette afspærredes af Kviksølvet, der optoges af en nedenunder anbragt passende Beholder. Som Resultat af de med dette Apparat udførte Forsøg udtalte Aimé den Sats, at den Mængde Luft, som indeholdtes i en bestemt Mængde Søvand, i alle Dyb var meget nær den samme.

[1] Ann. Chim. Phys. [3] — 7 — 497. Pogg. Ann. 30 — 412.

piratory process in marine animals, as stated by Dr. Jacobsen in the following words: — "Der Zusammenhang dieses Unterschiedes ist leicht zu deuten. In dem schwereren Wasser, welches ohne erhebliche Beimischung aus höheren Schichten sehr lange in der Tiefe verweilt, wird ohne genügenden Ersatz fortwährend Sauerstoff verbraucht zur Oxydation der im Wasser und besonders am Meeresgrunde vorhandenen oxydirbaren Stoffe, — in wahrscheinlich weit untergeordnetem Grade auch durch die Athmung der Thiere."

But the differences thus occasioned are not very great, since the percentage of oxygen, with but few exceptions, ranges from 30 to 34, as a rule diminishing with the depth.

Moreover, Jacobsen's observations, instituted under circumstances the most diverse, furnish incontestible proof, that the views of earlier authors, according to which the effect of solar light and storms, or indeed meteorological influence generally, was assumed to play an important part in modifying the composition of the air in surface-water, were wholly unfounded; nay, the extent to which the results based on that hypothesis are found to vary, will of itself show the comparative insignificance of such factors.

As regards the absolute amount of air contained in samples of water collected from different strata, this is found to increase with the depth, — a fact sufficiently obvious from the temperature diminishing as the depth increases, without needing to seek an explanation in the greater pressure. And with the object of showing that the proportion of air present in sea-water at great depths, is not, as assumed by some, to any appreciable extent dependent on the greater pressure prevailing there, a special series of experiments was instituted on the 'Pomerania' Expedition, with an apparatus for collecting water constructed of caoutschouc by Drs. Behrens and Jacobsen. This instrument was first pressed flat, and then sunk, after the air still remaining in it had been expelled by means of mercury, perfectly air-tight. On its striking the bottom, it opened and filled with water, after which it again closed, and was then brought up to the surface, air-tight as before. The samples of water collected in this apparatus were never found to contain more air than would be absorbed, with the same temperature, at the surface. That such must be the case, there was indeed reason to infer from the experiments instituted by Aimé[1] in 1843. Aimé made use of a glass tube, which, open at the upper extremity, was sunk full of mercury, and at the required depth inverted, causing part of the mercury in the tube to be replaced by water, in such manner that the mercury, flowing into a receiver of proper size and shape, prevented its escape. As the result of the experiments performed with this instrument, Aimé ventured to assume, that the proportion of air contained in a given quantity of sea-water, is at all depths very nearly the same.

[1] Ann. Chim. Phys. 3], 7, p. 497; Pogg. Ann. 30, p. 412.

I Aaret 1873 udgik atter fra England en Expedition, Challengerexpeditionen, som i et Tidsrum af 3 Aar skulde undersøge baade de æquatoriale og antarktiske Farvande. Med denne Expedition fulgte som Chemiker J. Y. Buchanan, som besluttede sig til at anvende de paa Pomeraniaexpeditionen benyttede Methoder og Apparater saa godt som uden Modifikationer. Resultaterne af hans Undersøgelser ere, saavidt jeg ved, endnu ikke offentliggjorte i sine Enkeltheder, medens der dog er gjort nogle foreløbige Meddelelser, hvorefter man vil kunne danne sig et Begreb om de Slutninger, hvortil hans Observationer ville føre.

Han finder[1], at Surstofmængden i Overfladevandet varierer mellem 33 og 35 % af den samlede Surstof-Kvælstofmængde, saaledes at den største Mængde er fundet (baade relativt og absolut) i Vandprøver øste i Nærheden af den sydlige Polarcirkel og den mindste i Pasatvindegnene. Hvad angaar de under Overfladen liggende Lag, da har han observeret det mærkelige Factum, at Surstofprocenten aftager nedover indtil et Dyb af 300 Favne, hvor den opnaar et Minimum for atter igjen at stige, saaledes som det fremgaar af følgende Tabel.

Dybde i engelske Favne.	0	25	50	100	200	300	400	800	Derover.
$O + N = 100$ O %	33.7	33.4	32.2	30.2	33.4	11.4	15.5	22.0	23.5

Om den absolute Mængde af de af hans Vandprøver udkogte Gasarter findes paa dette Sted Intet, hvorimod der senere er bleven offentliggjort følgende Tabel[2].

Dybde i Fod.	CC. O per Litre.	Middel Temperatur i °C. t.	CC. N per Litre N_1.	CC. N per Litre destill. Vand ved Temperat. t. Bunsen N_2.	$N_2 - N_1$
600	4.24	14.°6	11.26	11.75	0.49
1200	3.59	13. 0	11.71	11.92	0.21
1800	1.67	6. 9	13.00	13.45	0.45
2400	2.41	5. 1	13.10	14.00	0.90
4800	4.06	2. 5	13.82	15.00	1.14
derover.	—	1. 5	14.37	15.40	1.03

Hermed er i Korthed gjengivet det Vigtigste af de til Dato fremkomne Bidrag til Løsningen af Spørgsmaalet om Luften i Søvandet.

I Vaaren 1876, da man i Norge var beskjæftiget med Udrustningen af den Expedition, som var besluttet udsendt for i Sommermaanederne af Aarene 1876—77 og 78 at

[1] The Voyage of the 'Challenger.' The 'Atlantic,' 2 — 366.
[2] Ber. Berl. chem. Ges. 11 — 410.

In the year 1873, another Expedition was dispatched, from England, with H. M. S. 'Challenger,' its object being the investigation, during a period of 3 years, both of the Equatorial and the Antarctic Seas. As chemist to this Expedition, had been secured the services of J. Y. Buchanan, who resolved to adopt the methods and apparatus employed on the 'Pomerania' Expedition, almost without modification. The results of his labours are not yet, I believe, published in detail; preliminary papers have, however, appeared, from which we can form some general idea of his results.

Buchanan found[1] the proportion of oxygen in surface-water to vary between 33 and 35 per cent of the total amount of oxygen and nitrogen; it was greatest (both relatively and absolutely) in the samples of water drawn near the Antarctic Circle, and smallest in those collected within the region of the trade winds. As regards the proportion of oxygen in water below the surface, he observed the very remarkable fact, that it generally diminshes down to a depth of 300 fathoms, where a minimum is reached, and then begins to increase, as shown by the following Table.

Depth in English Fathoms.	0	25	50	100	200	300	400	800	Greater Dpths.
$O + N = 100$ O p. ct.	33.7	33.4	32.2	30.2	33.4	11.4	15.5	22.6	23.5

With respect to the absolute amounts of the gases boiled out of the different samples of water, nothing is stated in the work alluded to, but the following Table[2] has since appeared.

Depth in Feet.	CC. O per Litre	Mean Temperature in C. t.	CC. N per Litre N_1.	CC. N per Litre distilled Water, at Temp. t. Bunsen N_2.	$N_2 - N_1$
600	4.24	14.°6	11.26	11.75	0.49
1200	3.59	13. 0	11.71	11.92	0.21
1800	1.67	6. 9	13.00	13.45	0.45
2400	2.41	5. 1	13.10	14.00	0.90
4800	4.06	2. 5	13.82	15.00	1.14
Greater Depths.		1. 5	14.37	15.40	1.03

A brief account has now been given of what had previously been accomplished as regards the solution of the problem presented by the air in sea-water.

In the spring of 1876, when fitting out the Norwegian Expedition, which had for its object the investigation, during the summer months of 1876, 1877, and 1878, of

[1] The Voyage of the 'Challenger.' The 'Atlantic,' 2, p. 366.
[2] Ber. Berl. chem. Ges. 11, p. 410.

undersøge det mellem Norge, Færoerne, Island, Jan Mayen og Spitsbergen beliggende Hav, vare heller ikke de paa den engelske Challengerexpedition udførte Observationer offentliggjorte, saaat de Data, der den Gang forelaa, i Righoldighed paa ingen Maade kunde sammenlignes med dem, som nu staa til Raadighed. Især var det med Hensyn paa den geografiske Udbredning, at Observationerne ikke kunde give synderlg omfattende Oplysninger, idet det eneste Hav, som endnu var grundigt undersøgt, nemlig Nordsoen, baade med Hensyn paa Dybde og øvrige physikalske Forholde afveg i høi Grad fra det store Verdenshav, forsaavidt man kjendte det. Da der først var fattet Beslutning, om at der ogsaa paa den norske Nordhavsexpedition skulde udføres chemiske Undersøgelser af samme Art som paa de tidligere Expeditioner, maatte det derfor for Hr. S. Svendsen, hvem disse Arbeider oprindelig vare overdragne, fremstille sig som en meget vigtig, ja man kan sige, som den vigtigste Opgave at tilveiebringe de fornødne Oplysninger om Gasarterne i Søvandet, hvad angaar den Del af Verdenshavet, som Norge havde paataget sig at gjøre til Gjenstand for videnskabelig Undersøgelse. Med Hensyn paa de Midler, der skulde benyttes til Løsningen af denne Opgave, da kunde Valget af disse ikke falde vanskeligt, da de af Dr. Jacobsen benyttede Methoder og Apparater strax maatte udpege sig som de hensigtsmæssigste fremfor Alt, hvad der for Resten stod til Raadighed, selv om ikke Hensynet til Resultaternes Sammenlignelighed havde gjort deres Anvendelse ønskelig. Svendsen besluttede derfor uden Modificationer at optage de paa Pomeraniaexpeditionen benyttede Arbeidsmethoder, og var det i Henseende til Expeditionens Udrustning et stort Held, at Professor Dr. Jacobsen velvilligen tilbød sig at anskaffe de til de chemiske Undersøgelser fornødne Apparater.

Det var dog ikke alle de ved Pomeraniaexpeditionen benyttede Apparater, som ogsaa kom til Anvendelse paa den norske Nordhavsexpedition, idet man der besluttede at anvende en af Capitain Wille construeret Vandhenter, som især i en Henseende maatte være at foretrække for den af Dr. H. A. Meyer angivne. Paa denne maatte nemlig, naar den skulde optage Vandprøver fra intermediære Dyb, Cylinderen udløses ved et langs Linen nedsænket Lod, som aldeles udelukkede Muligheden af paa Linen samtidig at have anbragt Thermometre eller deslige, saaledes som det uden mindste Ulempe kan forenes med Brugen af Willes Vandhenter.

Willes Vandhenter, som findes afbildet i Fig. 2, er af Opfinderen bleven beskrevet paa følgende Maade:

"Vandprøven indesluttes i dette Instrument i et for Pladsens Skyld spiralformig bøiet Rør, der under Nedfiringen i Vandet holdes aabent i begge Ender, saaledes at Vandet frit kan strømme igjennem; men naar Instrumentet ophales et kort Stykke, lukkes Enderne af Røret med to Ventiler, hvorved det da i Røret staaende Vand afstænges og kan bringes op.

the sea lying between Norway, the Feröe Islands, Iceland, Jan Mayen, and Spitzbergen, the results of the observations instituted on the 'Challenger' Expedition had not yet been made public; and hence the data then obtained were few compared to those of which we are now in possession. It was more particularly with respect to geographical distribution, that the information former observations could supply had proved but meagre, inasmuch as the only sea thoroughly investigated, viz the German Ocean, was found to differ widely in regard to depth and other physical conditions from the Atlantic and Pacific, so far at least as our knowledge of both may be said to extend. The resolution once formed, of instituting on the Norwegian North-Atlantic Expedition a series of chemical experiments similar to those performed on former Expeditions, Mr. S. Svendsen, the gentleman on whom the execution of this task was to have devolved, could not but regard as an important, nay the most important, part of his labours, accurate determinations of the gases present in that tract of the Atlantic Ocean which the Norwegian Expedition was to make the subject of scientific investigation. Respecting the means whereby to solve this problem, no difficulty could be experienced in making a choice, since Dr. Jacobsen's methods and apparatus must at once suggest themselves as by far the best, even apart from the consideration, that, for the better comparing of his results with those obtained, their adoption was desirable. Svendsen, therefore, decided in favour of the process — without modification — resorted to on the 'Pomerania' Expedition; and it was a fortunate concurrence, that Professor Jacobsen should kindly volunteer his assistance in procuring the various apparatus necessary for the chemical experiments.

All the apparatus made use of on the 'Pomerania' Expedition, were not, however, adopted on the Norwegian North-Atlantic Expedition: the instrument, for instance, employed to collect water, which, particularly in one respect, must be held preferable to that described by Dr. H. A. Meyer, had been constructed by Captain C. Wille R. N. When drawing water from intermediate depths, the cylinder in the latter is detached by running a weight down the line, which precludes the possibilty of having a thermometer, or any other instrument, attached to it, an advantage which may, without the slightest drawback, be combined with Wille's apparatus.

Wille's instrument for collecting water, of which Fig. 2 is a represention, has been described by the inventor as follows: —

"The samples of water drawn with this instrument are, to save space, brought up in a spiral tube, which, when sunk through the water, is kept open at both ends, to admit of the free passage of the fluid; but, on the instrument, at the required depth, being hauled in a few fathoms, the ends of the tube are closed by means of two valves, and the water it contains, thus prevented from escaping, may be brought to the surface.

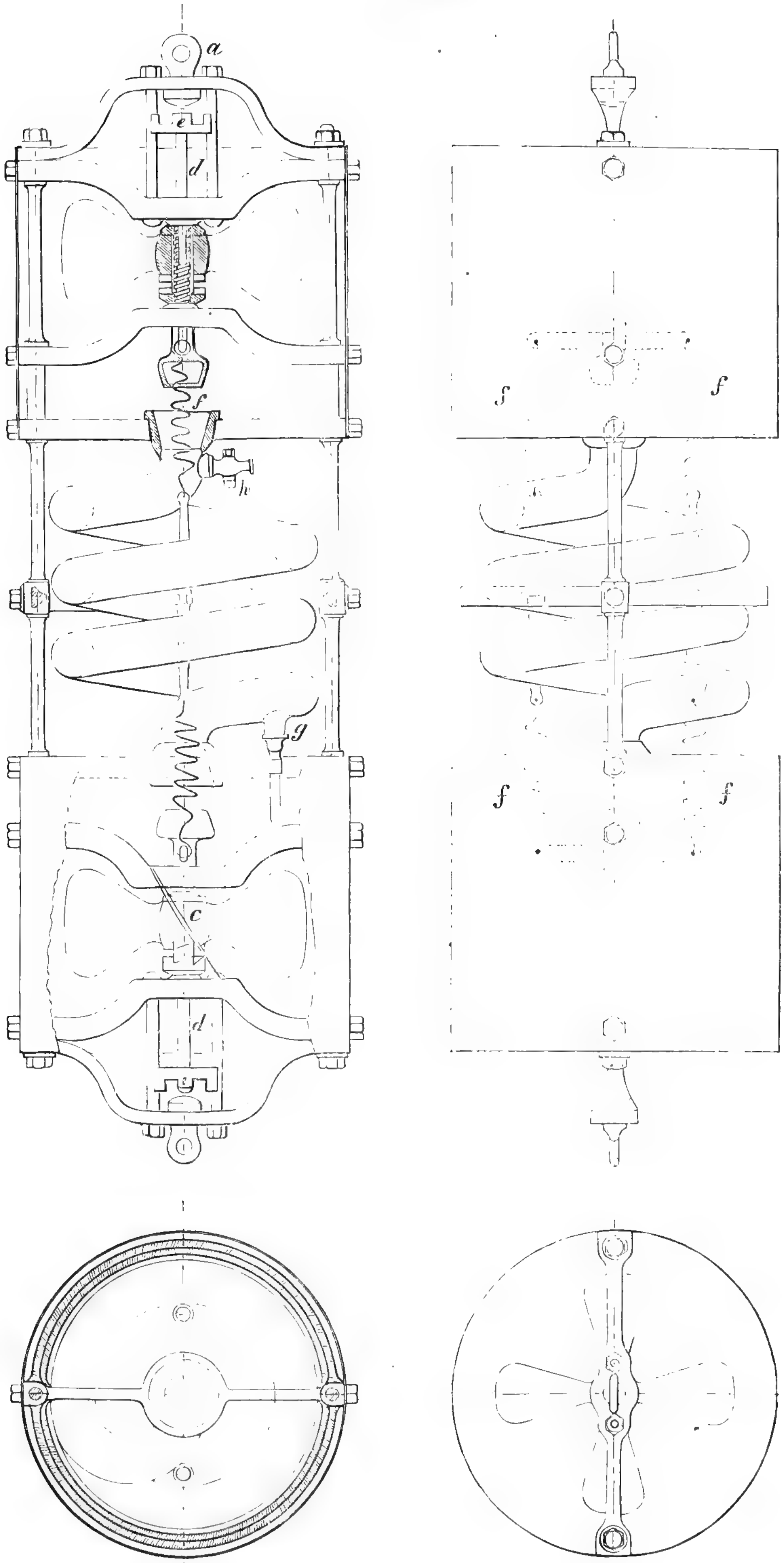


Fig. 2.
$^1/_8$ af naturlig Størrelse.
(One-eighth of the Actual Size.)

Tegningen fremstiller Instrumentet klar til Nedfiring; Tampen af Lodlinen hexes i øverste Øiebolt (*a*) og Loddet i den nedre (*b*). Under Nedfiringen løfter Vandtrykket Propellerne op, saa at Taggerne i Underkant af Propelbosset (*c*) kommer klar af Taggerne i Muffen, gjennem hvilken Ventilstangen (*d*) gaar, og om de ikke kommer ganske klare, sker Propellens Omdreining *med* Skraaplanerne, saa at Muffen og Ventilstangen bliver staaende stille. Naar Instrumentet derimod under Ophalingen bevæges opad, driver Vandtrykket Propellerne ned, de dreies rundt den anden Vei og tager Mufferne med sig. Ventilstængerne, der ikke kan dreie sig rundt, men styres af Tværstykkerne (*e*), skrues da, tilligemed de med Kautschuk overtrukne Ventiler, mod Ventilsæderne i Enderne af Røret, og naar de ere næsten lukkede, glipper den sidste Skruegjænge paa Ventilstangen ud af Skruegjængerne i Muffen, og Spiralfjædrene (*f*) klappe da Ventilerne i, medens Propellerne og Mufferne gaa løse rundt om den glatte Del af Ventilstængerne, og frembyder saaledes meget liden Modstand under Resten af Indhivningen. Instrumentet lukker sig efter omtrent 7 Favnes (13 Meters) Indhaling. Ringen om Midten og Skjærmerne rundt Propellerne beskytte Instrumentet, saaledes at det uden Skade kan ligge paa Bunden.

For at konstatere, om der var Overskud af Luft i de nedre Vandlag, blev der over Svikhullet paaskruet et gjennemboret Laag (*g*), der ved Hjælp af et Stykke Gummislange forenedes til et i den ene Ende lukket Glasrør. Naar Vandet under Nedfiringen strømmede ind i Vandrøret, løb det ogsaa ned i Glasrøret, af hvilket Luften saaledes blev udjaget. Naar Instrumentet kom ombord, endevendtes det, saa at Kranen kom ned og Glasrøret op. Man bevægede nu Vandhenteren lidt frem og tilbage med den øvre Ende, og hvis der havde været Overskud af Luft, maatte denne have arbeidet sig op og vist sig i Toppen af Glasrøret, men dette viste sig stadig fuldt lige til Tops, og blev derfor i den sidste Tid ikke paasat."

Instrumentet kan tømmes gjennem Tappekranen (*h*) og leverer en Vandprøve paa circa 5 Litre.

Udførelsen af de chemiske Arbeider ombord paa den norske Nordhavsexpedition overtoges altsaa først i Følge den oprindelige Plan af Hr. Svendsen, som gjorde Togtet i 1876 med, men blev senere, da denne af Helbredshensyn bad sig fritaget, overdraget Forfatteren, der saaledes har udført de paa de to sidste Togter gjorte Observationer delvis med Assistance af Hr. L. Schmelck, som sidste Sommer medfulgte Expeditionen, og som for Tiden er beskjæftiget med Bearbeidelsen af en anden Del af det paa Expeditionens Togter til chemisk Undersøgelse indsamlede Materiale.

The figure shows the instrument ready for sinking. The end of the sounding-line is made fast to the upper eyebolt (*a*), and the lead to the lower (*b*). On the downward passage, the pressure of the water lifts up the propellers, enabling the cogs in the under surface of the base of the latter (*c*) to get clear of the cogs in the bush, through which passes the rod of the valve (*d*); and if not quite clear, the propeller revolves *with* the inclined planes, the bush and the rod of the valve remaining stationary as before. On the other hand, when the instrument, on being hauled in, is given an upward motion, the pressure of the water forces down the propellers, which then revolve in the opposite direction, carrying along with them the bushes. The rods of the valves, which cannot revolve, being kept in position by transverse pieces (*e*), are, together with the valves covered with caoutschouc, screwed against the ends of the tube. Now, when the latter are almost closed, the last twist of the screw on the rod of the valve slips out of the corresponding twist of the screw on the bush, and the spiral springs (*f*) instantly press down the valves, the propellers and the bushes revolving independently round the smooth portion of the rods, thus presenting but little resistance to the water during the remainder of the upward passage. The instrument closes on being hauled in about 7 fathoms (13 metres). The ring round the middle, and the shields protecting the propellers, prevent the instrument from sustaining injury on its striking the bottom.

With a view to ascertain whether the proportion of air were really greater in the lower strata, a perforated cover (*g*) was screwed over the spigot-hole, and connected by means of a piece of caoutschouc hose with a glass tube, open at one end. Now, when the water on the downward passage flowed into the spiral tube, it also descended into the glass tube, expelling the air. So soon as the instrument came on board, it was inverted, the stop-cock therefore pointing down, and the glass tube up. The upper end of the apparatus being now moved a little backwards and forwards, the surplus of air, if any had been present, must obviously have forced its way upwards, and have appeared, in the form of bubbles, at the top of the tube, which, however, was invariably found to be quite full, and therefore not attached to the apparatus when the fact would no longer admit of doubt."

The stopcock (*h*) serves to empty the instrument, which will hold about 5 litres of water.

The chemical work to be done on board was, as stated above, originally undertaken by Mr. S. Svendsen, who went out on the first cruise, in 1876; but, his health failing, Mr. Svendsen was succeeded by the author, who had therefore to take the observations instituted in 1877 and 1878, partly with the assistance of Mr. L. Schmelck, that gentleman having accompanied the Expedition on the last cruise. (Mr. Schmelck is now engaged in working up other materials collected on the Expedition for chemical investigation).

Da jeg Vaaren 1877 blev opfordret til at overtage disse Arbeider, var der kun givet mig faa Dages Varsel, saaat jeg havde de største Vanskeligheder med at faa udført selv de aller nødtorftigste Forberedelser, og naar det alligevel lykkedes at faa Alt tilfredsstillende ordnet for Afreisen, da skyldes dette udelukkende den Beredvillighed, hvormed Hr. Professor Waage bistod mig blandt Andet ogsaa med Indredningen af det chemiske Laboratorium ombord.

Det paa Expeditionens første Togt i 1876 fremherskende ualmindeligt stormfulde Veir gjorde det i høi Grad vanskeligt ja næsten ugjørligt at udføre de chemiske Observationer ombord, og det Udbytte, som af Svendsen hjembragtes fra første Togt, indskrænkede sig derfor i denne Branche til 17 Luftprøver, hvoraf desuden 3 ved Uheld senere gik tabt. Det rolige Veir, som de to sidste Aar begunstigede Expeditionens Arbeider, tillod mig derimod paa de Togter, hvormed der var givet mig Anledning til at medfølge, at indsmelte et større Antal, idet der for disse Aars Vedkommende erholdtes 80 Luftbestemmelser af de hjembragte Luftprøver, hvoraf 9 vare indsmeltede af Hr. Schmelck. Naar Udbyttet ikke er blevet større, da har dette sin Grund i, at talrige Observationer gik tabt nogle faa ved Uheld under Analysen men de fleste ved Uheld under Indsmeltningen. Saaledes var der til Brug paa sidste Togt fra Küchler & Söhne i Ilmenau sendt mig nogle Luftopsamlingsrør, hvoraf over 75 % tiltrods for den omhyggeligste Behandling sprang enten under Indsmeltningen eller efter samme. Luftprøverne ere alle analyserede ved det af Franckland og Ward[1] angivne Gasanalyseapparat, saaledes at Kulsyren er fjernet med Kalilud og Surstoffet bestemt ved Forbrænding med Vandstof. De 14 forstnævnte Prøver ere analyserede af Hr. Svendsen de øvrige 80 af Forfatteren. De erholdte Resultater findes sammenstillede i Tabel I, hvortil kan bemærkes følgende: De i Tabellen opførte Temperaturangivelser ere mig meddelte af Professor Mohn. Ved Angivelse af de Dybder, hvorfra Vandprøverne ere hentede, er ikke taget Hensyn til, at Vandhenteren først lukker sig efter circa 7 Favnes Indhivning. Ved de med * betegnede 10 Nummere var der i de til Luftprøvernes Opbevarelse benyttede Glasrør smaa Feil, uden at jeg dog har fundet mig foranlediget til at tillægge disse mindre Vægt end de Øvrige, da man vel ikke kan tænke sig Muligheden af en Lækage, uden at den, naar Glasrørene i flere Maaneder opbevaredes under en Trykdifferents mellem det ydre og indre Gastryk af circa 300 til 400^{mm}, maatte have øvet en mærkbar Virkning paa den indesluttede Lufts Sammensætning. Jeg kan saa meget trøstigere tage dem med i Beregningerne, hvor det gjælder at opstille de almindelige Slutninger, som de ikke i synderlig Grad ville bidrage til at forrykke Udseendet af de endelige Resultater. Alle Gasvolumina findes i Tabellen udtrykte i CC. per Litre udkogt Søvand reduceret til 0° og 760^{mm} Barometerstand.

[1] Chem. Soc. Journ. 22–313. 1869.

When, in the spring of 1877, I was requested to undertake these labours, I had but a few days' notice, and experienced, therefore, very great difficulty in making even the most necessary preparations; nor would it indeed have been possible to get everything satisfactorily arranged in so short a time but for the readiness with which Professor Waage came forward to assist me; for instance, in fitting up the chemical laboratory on board.

The exceptionally heavy weather on the first cruise in 1876, rendered it in the highest degree difficult, nay well nigh impracticable, to perform the necessary experiments on board; and hence the chemical work done by Svendsen on the first voyage was, with regard to gas-determinations, confined to collecting 17 samples of air, 3 of which however were subsequently lost. On the two last cruises of the Expedition the weather proved much more favourable, and I succeeded in obtaining a larger number of samples (9 of them collected by Mr. Schmelck), with which, when brought home, 80 air-determinations were performed. A more satisfactory result would, however, have been obtained but for the loss of numerous samples, some few from accident when analysing the gass, but the great majority by reason of the difficulty experienced in sealing. Thus, for instance, on the last voyage 75 per cent of the glass tubes for collecting air, procured from Küchler & Sohne in Ilmenau, notwithstanding the greatest care cracked either during the sealing-process or after its completion. The samples of air were all of them analysed in the apparatus described by Franckland and Ward,[1] the carbonic acid having been absorbed in a lye of potash and the oxygen determined by consuming it with hydrogen. The first 14 samples were analysed by Mr. Svendsen, the remaining 80 by myself. The results obtained will be found in Table I. The temperatures in the Table were given by Professor Mohn. When stating the depths from which the samples of water were drawn, regard has not been had to the fact, that the instrument used for collecting them does not close till it has been hauled in about 7 fathoms. The asterisk marking 10 of the determinations signifies that the glass tubes used for preserving these samples of air had small defects. To these determinations, however, I have not attached less weight than to the others; for it is impossible to conceive that a leakage, after the glass tubes had been exposed for months together to a difference of pressure amounting to 300^{mm}—400^{mm}, viz. that existing between the air inside and the atmosphere without, should not have had an appreciable effect on the composition of the air they contained. Moreover, I hesitate the less to include them as factors when seeking to arrive at general conclusions, since they cannot to any considerable extent disturb the character of the final results. The volumes are given in cubic centimetres per litre of the sea-water examined, reduced to a temperature of 0° and a pressure of 760^{mm}.

[1] Chem. Soc. Journ. 22, p. 313; 1869.

Tabel I.

No.	Stat. No.	Nordlig Bredde. (*North Latitude.*)	Længde fra Greenwich. (*Longitude from Greenwich.*)	Dybde hvorfra Proven hentet. (*Depth from which the Samples were collected.*) Engelske Favne. (*English Fathoms.*)	Meter. (*Metres.*)	O + N CC. per Litre.	N CC. per Litre.	O + N = 100 O % (*O per cent.*)	Temperatur. Celsius.	Anmærkninger. (*Remarks.*)
1		Husö		0	0	17.4	11.3	35.1	10.5	
2	14	62° 4′	2° 44′.5 E.	226	413	20.1	13.8	31.1	6.1	
3	32	63 10	4 51.3	430	786	19.0	13.0	31.7	—0.6	
4	33	63 5	3 0	0	0	18.9	12.4	34.4	11.8	
5	33	63 5	3 0	525	960	17.3	11.7	32.6	—1.1	
6	35	63 7	1 26 W.	0	0	17.0	11.1	35.0	10.4	
7	35	63 7	1 26	721	1319	18.4	12.4	32.6	—0.9	
8	37	62 28.3	2 29	309	565	18.5	12.4	32.8	0.1	
9	37	62 28.3	2 29	690	1262	18.3	12.3	32.7	—1.1	
10	40	63 22.5	5 29	0	0	17.1	11.1	35.2	9.7	
11	40	63 22.5	5 29	515	942	20.5	13.9	32.4	—0.4	
12	51	65 53	7 18	515	942	20.6	13.9	32.3	—0.6	
13	51	65 53	7 18	1163	2127	20.9	14.1	32.7	—1.1	
14	52	65 47.5	3 7	1861	3403	—	—	32.2	—1.2	
15	95	60 42	4 13.7 E.	175	320	—	—	32.4	5.8	
16	96	66 8.5	3 0	805	1472	—	—	32.3	—1.1	
17	125	67 52.5	5 12	700	1280	20.5	13.7	33.0	—1.1	
18	125	67 52.5	5 12	700	1280	20.0	13.3	33.6	—1.1	
19	152	67 18	12 46	125	229	—	—	31.0	4.1	
20	162	68 23	10 20	795	1454	20.6	13.9	32.6	—1.2	
21	162	68 23	10 20	795	1454	19.4	12.9	33.7	—1.2	Udkogt efter nogen Tids Henstand. (Boiled after the lapse of a short interval.)
22	171	69 18	14 29	642	1174	19.6	13.0	33.5	—1.0	
23	179	69 32	11 10	1607	2939	—	—	32.1	—1.2	
24	183	69 59.5	6 15	0	0	20.2	12.9	36.1	8.6	
25	183	69 59.5	6 15	0	0	—	—	36.1	8.6	
26	184	70 4	9 50	1547	2829	21.5	14.6	32.0	—1.3	
27	184	70 4	9 50	600	1097	20.7	14.1	32.1	0.0	
28	189	69 41	15 42	0	0	18.4	12.0	35.0	9.6	
29	189	69 41	15 42	860	1573	21.5	14.6	32.0	—1.1	
30	200	71 25	15 40.5	620	1134	19.9	12.8	35.8	—1.0	Udkogt efter 5—6 Timers Henstand. (Boiled after the lapse of 5 or 6 hours.)
31		Indløbet til Malangenfjord. (Entrance to the Malangen Fjord.)		0	0	—	—	35.5	8.5?	
32	213	70° 23′	2° 30′	0	0	18.6	12.1	34.9	8.2	
33	213	70 23	2 30	1760	3219	19.6	12.9	34.0	—1.2	
34	213	70 23	2 30	1760	3219	—	—	33.8	—1.2	
35	215	70 53	2 0 W.	0	0	—	—	34.8	8.0	
36	215	70 53	2 0	700	1280	20.1	13.6	22.4	—0.6	
37	215	70 53	2 0	1665	3045	19.2	12.9	32.8	—1.2	
38	226	70 59	7 51	0	0	—	—	33.7	3.0	
39	226	70 59	7 51	340	622	—	—	32.7	—0.6	
40	—	69 20	11 18	0	0	20.7	13.3	35.8	4.3	
41	—	69 20	11 18	0	0	—	—	35.4	4.3	
42	243	68 32.5	6 26	0	0	20.0	13.1	34.7	7.8	
43	243	68 32.5	6 26	600	1097	22.1	15.0	32.2	—0.8	
44	243	68 32.5	6 26	1385	2533	22.6	15.3	32.5	—1.3	
45	247	68 5.5	2 24 E.	0	0	19.3	—	—	9.4	
46	247	68 5.5	2 24	500	914	—	—	32.3	—0.4	
47	249	68 12	6 35	1063	1944	21.4	14.5	32.3	—1.3	
48	252	Søndenfor Skraaven. (South of Skraaven.)		0	0	18.2	11.9	34.7	14.0?	
49	253	Skjærstadfjord. (The Skjærstad Fjord.)		263	481	20.9	13.8	34.2	3.2	
50	254	67° 27′	13° 25′	0	0	18.2	11.9	34.8	10.0	
51	254	07 27	13 25	70	128	21.3	14.2	33.2	4.8	
52	254	67 27	13 25	140	256	19.5	13.2	32.4	5.8	
53	264	70 56	35 37	0	0	20.6	13.3	35.5	5.2	
54	264	70 56	35 37	86	157	20.7	13.8	33.1	1.9	
55	275	74 8	31 12	0	0	20.5	13.3	34.9	2.9	
56	275	74 8	31 12	147	269	21.9	14.6	33.4	—0.4	
57	278	74 1.5	22 27	0	0	20.4	13.3	35.0	4.2	
58	278	74 1.5	22 27	230	421	20.7	13.8	33.3	0.9	

No.	Stat. No.	Nordlig Bredde. (North Latitude.)	Længde fra Greenwich. (Longitude from Greenwich.)		Dybde hvorfra Prøven hentet. (Depth from which the Samples were collected.) Engelske Favne. (English Fathoms.)	Meter. (Metres.)	O + N CC. per Litre.	N CC. per Litre.	O + N = 100 O % (O per cent.)	Temperatur. Celsius.	Anmærkninger. (Remarks.)
59	283	73° 47′.5	14° 21′		0	0	19.8	12.8	35.4	7.2	
60	283	73 47.5	14 21		0	0	19.5	12.6	35.3	7.2	
61	286	72 57	14 32		0	0	20.6	13.2	35.8	7.2	
62	286	72 57	14 32		447	817	21.8	14.8	31.9	—0.8	
63	293	71 7	21 11		95	174	19.6	13.0	33.5	5.1	
64	295	71 59	11 40		0	0	20.2	12.8	36.7	7.0	
65	295	71 55	11 30		600	1097	21.4	14.6	31.7	—0.8	
66	295	71 59	11 40		1110	2030	21.5	14.6	32.1	—1.3	
67	296	72 15.5	8 9		100	183	20.4	13.4	34.2	3.1	
68	297	72 36.5	5 12		1280	2341	21.3	13.8	35.1	—1.4	
69*	301	74 1	1 20	W.	0	0	21.9	14.1	35.6	2.2	
70*	303	75 12	3 2	E.	150	274	22.0	14.7	33.1	—1.1	
71*	304	75 3	4 51		300	549	21.7	14.7	32.2	—0.8	
72	304	75 3	4 51		1735	3173	21.6	14.6	32.2	—1.5	
73*	321	74 56.5	19 30		0	0	23.8	15.4	35.2	0.5	
74	321	74 56.5	19 30		25	46	23.7	15.3	35.4	0.2	
75	323	72 53.5	21 51		0	0	19.3	12.3	36.5	7.8	
76	323	72 53.5	21 51		0	0	—	—	35.8	7.8	
77	332	75 56	11 36		1149	2101	21.9	14.8	32.2	—1.5	
78	332	75 56	11 36		1149	2101	22.0	15.0	31.8	—1.5	
79	335	76 16.5	14 39		0	0	20.8	13.3	36.2	5.4	
80	335	76 16.5	14 39		179	327	21.0	14.0	33.1	1.0	
81	339	76 30	15 39		37	68	21.6	14.2	34.1	0.9	
82	342	76 33	13 18		0	0	21.8	14.1	35.3	6.2	
83	342	76 33	13 18		523	956	20.8	13.8	33.8	—1.0	
84	345	76 42.5	10 9		300	549	20.9	13.7	34.4	1.0	
85	345	76 42.5	10 9		300	549	21.5	14.2	33.9	1.0	
86	347	76 40.5	7 47		0	0	20.9	13.4	35.7	4.4	
87	347	76 40.5	7 47		1429	2613	21.4	13.9	35.1	—1.3	
88*	349	76 30	2 57		1487	2719	21.7	14.6	32.5	—1.5	
89	350	76 26	0 29	W.	300	549	21.9	14.7	32.7	—1.1	
90	350	76 26	0 29		1686	3083	22.9	15.3	33.3	—1.5	
91*	352	77 56	3 29	E.	300	549	21.9	14.8	32.5	—0.8	
92*	352	77 56	3 29		1686	3083	22.4	15.1	32.8	—1.5	
93*	359	78 2	9 25		0	0	—	—	35.7	4.3	
94*	362	79 59	5 40		0	0	20.3	13.0	35.8	5.2	

Vandprøverne ere overalt, hvor det Modsatte ikke udtrykkelig er anført, udkogte strax efter deres Optagelse.

Som man ser, ligner denne Tabel overmaade meget den af Dr. Jacobsen opstillede, hvad man ogsaa paa Forhaand kunde vente, da de undersøgte Districter fuldstændig gaa over i hinanden, og naar Differentserne mellem de af Hr. Svendsen og mig opførte Tal ere noget større, da kommer dette ligefrem af det af os bearbeidede Felts større Udstrækning og deraf følgende større Uensartethed i de physikalske Forholde.

Hvad der er mest ioinefaldende, er det paafaldende Phænomen, at der med Hensyn paa den relative Sammensætning af den i Overfladevandet indeholdte Luft paa den norske Nordhavsexpedition er fundet betydeligt større Surstofgehalt end af Dr. Jacobsen for Nordsøen opstillet, saaledes er Surstofprocenten i Overfladen i Nordsøen bestemt til i Middel 33.93 % af den samlede Luftmængde, medens den for det af den norske Expedition i 1876 og 77 undersøgte Strog søndenfor den 70de Breddegrad, beløber sig

The samples of water were all, except when the reverse is stated, boiled immediately on being drawn.

As will be seen, this Table agrees very closely with that prepared by Dr. Jacobsen, which was indeed to be expected, since the tracts investigated coalesce; and the somewhat greater differences exhibited by Mr. Svendsen's and my own figures arise simply from the region explored by the Expedition having been more extensive, involving greater dissimilarity in the physical conditions.

With regard to the relative composition of the air in surface-water, the proportion of oxygen was, strange to say, on the Norwegian North-Atlantic Expedition found to be considerably greater than that given by Dr. Jacobsen for the North Sea. The mean proportion of oxygen in the surface-water of the North Sea he determined to be 33.93 per cent of the total amount of air, whereas the mean proportion for the tract of the North-Atlantic stretching south of the 70th parallel of latitude, that investigated by the

til i Middel 34.96 og for det i 1878 undersøgte mellem 70de og 80de Breddegrad beliggende Strøg til 35.64 %. Fuldstændigt tilsvarende er det af Buchanan fundet at være paa den sydlige Halvkugle, idet Surstofprocenten i Overfladen der varierer fra omkring 33 i Æqvatoregnene til ca. 35 omkring den sydlige Polarcirkel.

Dette lod med temmelig stor Bestemthed formode, at de for destilleret Vand gjældende, af Bunsen opstillede, Absorbtionscoefficienter ikke skulde være gyldige for Søvand, idet det, naar Overfladevandsluftens Sammensætning fandtes at variere med Bredden, maatte være det Naturligste at skrive disse Variationer paa Temperaturforandringerne. Det vil imidlertid ikke føre til noget rimeligt Resultat, om man vil betragte Temperaturen som den Variable og af de her foreliggende Observationer forsøge at udlede en Lov for Absorbtionscoefficienternes Variationer med Temperaturen. Man vil da finde, at de enkelte Observationer staa ikke ubetydeligt i Strid med hinanden, idet der for Surstofmængdernes Vedkommende overalt optræder meget større Afvigelser, end man kan antage begrundede i Observationsfeil. Det kunde dog ikke synes tilraadeligt at lade det bero hermed og forsøge at discutere de foreliggende Observationer uden nøiere Kjendskab til Absorbtionscoefficienternes Afhængighed af Temperaturen, og jeg besluttede derfor at bestemme saavel Sammensætning som Mængde af den i Søvandet ved forskjellige Temperaturer opløste Luft.

Først gjordes en Del Forsøg, hvorved Søvandet i et Bad af constant Temperatur søgtes mættet ved flere Timers Gjennemledning af Luft, (saaledes som Bunsen har gaaet frem ved sine Bestemmelser[1]), hvorefter den opløste Luft uddreves og analyseredes paa den før beskrevne Maade. De paa denne Maade mættede Vandprøver afgave bestandig Luftmængder, som uden Hensyn til den Temperatur, hvorved Vandet var mættet, viste nogenlunde nær den samme Sammensætning (med 34.9 % Surstof mod 65.1 % Kvælstof), medens de ofte temmelig stærkt afvigende Tal, som udtrykte de absolute Mængder af opløste Gaser, tydeligt viste, at der paa denne Maade ikke var opnaaet fuldstændig Mætning.

Professor Waage foreslog mig derfor at gjentage disse Forsøg med nogen Variation i den Maade, hvorpaa Mætningen iværksattes, og har jeg som Følge deraf ved de senere Forsøg benyttet følgende Fremgangsmaade. En passende Portion Søvand af nogenlunde høi Egenvægt rystedes med Luft i en rummelig Kolbe i et Tidsrum fra 1 til 2 Timer under stadig Vexlen af den i Kolben værende Luft og hensattes derpaa i nogle Timer ganske rolig, idet Temperaturen saavel under Rystningen som senere holdtes fuldstændig constant. Forat overbevise mig om, at jeg har opnaaet fuldstændig Mætning, har jeg nærmet mig Mæt-

[1] Bunsen, Gasom. Methoden — 165.

Norwegian Expedition in 1876 and 1877, amounts to 34.96, and for that lying between the 70th and 80th parallels of latitude, to 35.64 per cent. Buchanan observed precisely the same phenomenon in the southern hemisphere, the proportion of oxygen varying from about 33 per cent in the Equatorial Seas to about 35 per cent in the vicinity of the Antarctic Circle.

Reasoning on these data, there were strong grounds to assume, that the coefficients of absorption given by Bunsen for distilled water could not apply to sea-water; for, the composition of the air in surface-water having been found to vary with the latitude, the most probable cause of this phenomenon would seem to be temperature. Meanwhile, we shall not arrive at a satisfactory result by regarding temperature as the variable factor, and by seeking from the observations here set forth to discover a law according to which the coefficients of absorption vary with the temperature. The individual observations would in that case be found to clash, inasmuch as the variation with regard to oxygen is invariably greater than can be assumed to arise from errors of observation. However, it did not seem advisable to leave the question as it stood, and proceed to the discussion of the results without having further investigated the relation of the coefficients of absorption to the temperature; and I resolved, therefore, on determining alike the composition and the amount of the air absorbed by sea-water at different temperatures.

A series of experiments were first instituted with a view to saturate sea-water with air, viz. by placing it in a bath of constant temperature, and for the space of several hours uninterruptedly conducting through it a current of air, — the mode of operation adopted by Bunsen for his determinations,[1] — after which the air absorbed in the water was driven off, and analysed by the process previously described. The samples of water saturated in this manner invariably yielded quantities of air which, irrespective of the temperature at which the water had been saturated, were found to be very nearly uniform in composition, viz. 34.9 per cent oxygen and 65.1 per cent nitrogen, whereas the figures, often widely divergent, expressing the absolute quantities of the gaseous bodies absorbed, gave sufficient proof that by this method complete saturation had not been attained.

At Professor Waage's suggestion, I repeated these experiments, varying slightly the means by which saturation was sought to be effected, and have since adopted the following mode of operation. A quantity of sea-water, of considerable specific gravity, is shaken, along with air, in a roomy matrass for one or two hours, the air in the matrass being frequently renewed, and then left perfectly still for a few hours, at the precise temperature preserved during its continual agitation. To be quite sure that I have really succeeded in saturating the water, I approach the point of saturation as it were from opposite directions:

[1] Bunsen, Gasom. Methoden, p. 165.

ningspunctet fra begge Sider, idet jeg paa den ene Side har behandlet Vand, som paa Forhaand var utilstrækkeligt mættet med Luft ved vedkommende Temperatur, og paa den anden Side først har mættet Vandet ved en betydelig lavere Temperatur for derefter, som ovenfor beskrevet, at ryste det med Luft ved den Temperatur, hvorved det ønskedes mættet. Den Barometerstand, hvorved Vandprøverne ere mættede, er altid bleven observeret, og ere de uddrevne Gasmængder reducerede til Mætning ved 760^{mm}, idet de absorberede Volumina ere satte proportionale med Trykket. Resultaterne ere sammenstillede i nedenstaaende Tabel, hvor Gasmængderne ere udtrykte som CC. pr. Litre udkogt Vand reduceret til 0° og 760^{mm} Tryk. De med fede Typer trykkede Tal hidrøre fra de Vandprøver, der i Forveien have været mættede med Luft ved en lavere Temperatur. Ved de med Klammer sammenføiede Tal ere begge Luftprøver udkogte af samme Vandprøve.

0° C.		5° C.		10° C.		15° C.	
O	N	O	N	O	N	O	N
7.76	14.36	6.83	13.20	6.31	12.14	5.60	10.79
7.85	14.56	6.90	13.30	**6.30**	**12.06**	5.79	11.20
7.71	14.31	**6.97**	**13.16**	**6.25**	**12.04**	**5.70**	**11.04**
—	—	**7.01**	**13.20**	—	—	—	—

Som Middelværdier erholder man heraf:

° C.	0	5	10	15
O	7.77	6.93	6.29	5.70
N	14.41	13.22	12.08	11.01
$O + N = 100$ O %	35.03	34.39	34.24	34.11

Til yderligere Control paa Rigtigheden af denne Tabel hensattes en Vandprøve i uproppet Kolbe ved 0° i 7 Døgn, hvorpaa den deri opløste Luft udkogtes og analyseredes, og viste den uddrevne Gas sig at være omtrentlig af samme Sammensætning som ovenfor angivet nemlig 35.18 % O mod 64.82 % N. Af den samlede Luftmængde erholdtes her ingen Maaling, da desværre en liden Blære under Overfyldningen i Eydiometret gik tabt, den resterende Del maalte 21.71 CC. Som man af denne Tabel vil kunne se, er den Kvælstofmængde, som 1 Litre Søvand absorberer af den atmosphæriske Luft, ligetil proportional med Temperaturen og lader sig udtrykt i CC. meget nøie fremstille ved Formelen

$$N = 14.4 - 0.23\,t,$$

hvoraf man istedetfor de

observerede Værdier .	14.41	13.22	12.08	11.01
kan beregne	14.40	13.25	12.10	10.95.

Hvad angaar den absorberede Surstofmængde, da er Forholdet ikke længere saa simpelt, idet den Curve, der betegner Variationen med Temperaturen, ikke længere er en ret men en svagt krummet Linie, som paa Strøget fra 0 til 10°, hvorom der her nærmest er Tale, lader sig udtrykke ved Formelen

on the one hand, operating with water that has been imperfectly saturated at a given temperature, and on the other, saturating that water at a much lower temperature; and not till then proceeding to shake it along with air at the temperature for which saturation is sought to be attained. The atmospheric pressure at which the samples of water were saturated, was always noted down, and the quantity of gas driven off reduced to the point of saturation at 760^{mm}, the volumes absorbed being put proportional with the pressure. The results are set forth in the following Table, the amounts of gas being expressed in cubic centimetres per litre of the water examined, reduced to a temperature of 0° and a pressure of 760^{mm}. The figures printed in thick type refer to samples of water previously saturated with air at a lower temperature; those in brackets are determinations performed with the same sample of water.

0° C.		5° C.		10° C.		15° C.	
O	N	O	N	O	N	O	N
7.76	14.36	6.83	13.20	6.31	12.14	5.60	10.79
7.85	14.56	6.90	13.30	**6.30**	**12.06**	5.79	11.20
7.71	14.31	**6.97**	**13.16**	**6.25**	**12.04**	**5.70**	**11.04**
—	—	**7.01**	**13.20**	—	—		

The mean proportions are accordingly: —

C.	0°	5°	10°	15°
O	7.77	6.93	6.29	5.70
N	14.41	13.22	12.08	11.01
$O + N = 100$ O p.ct.	35.03	34.39	34.24	34.11

With the object of testing still further the accuracy of this Table, a sample of water was allowed to stand over in an open matrass at a temperature of 0° for the space of 7 days, when the air absorbed by it was boiled out and analysed; but the composition of the gas driven off proved to be almost the same as that specified above, viz. 35.18 per cent oxygen and 64.82 per cent nitrogen. Of the total amount of air no measurement was obtained, a small bubble of gas having unfortunately escaped when transferring the air into the eudiometer; the remaining portion measured 21.71^{cc}. As appears from this Table, the quantity of nitrogen absorbed from the atmosphere by 1 litre of sea-water is strictly proportional to the temperature, and may be very accurately expressed in cubic centimetres by the formula —

$$N = 14.4 - 0.23\,t,$$

which, in place of

the values observed.	14.41	13.22	12.08	11.01
gives	14.40	13.25	12.10	10.95

With regard to the amount of oxygen absorbed, the proportion is less easily expressed, since the curve indicating the variation with the temperature will no longer be a straight, but a slightly curved line, which, from 0° to 10°, the interval most important here, may be expressed by the formula —

$$O = 7.79 - 0.2\,t + 0.005\,t^2,$$

som istedetfor de observerede Værdier 7.77 6.93 6.29
giver 7.79 6.92 6.29

Men Hensyn paa den relative Sammensætning af den absorberede Luft da er den ikke, saaledes som af Bunsen for destilleret Vand fundet, uafhængig af Temperaturen men varierer med denne, saaledes at Surstofprocenten paa Strøget fra 0° til 15° forandrer sig med en hel Procent.

Betragter man Resultaterne af disse Forsøg som Norm, viser det sig, at den relativt til den samlede Luftmængde meget høie Surstofgehalt, som er observeret i Overfladen i den nordlige Halvdel af det undersøgte Hav, i Virkeligheden skriver sig fra en Overmætning med Surstof og ikke, som man ogsaa kunde tænkt, fra en mangelfuld Mætning med Kvælstof, idet der mærkeligt nok her findes en Surstofgehalt, der meget hyppigt overskrider den af disse Forsøg beregnede med 0.5 CC. og derover. Det vil sige, der optræder saa store Afvigelser, at de paa ingen Maade kunne tilskrives Observationsfeil, og det viser sig saaledes, at Surstofgehalten i Overfladen ikke alene afhænger af Tryk og Temperatur, men rimeligvis ogsaa maa paavirkes af en eller flere andre ubekjendte Aarsager.

Naar det gjælder nærmere at studere Surstofmængdens Variation med Dybden, falder det bekvemmest at udtrykke den som Procenter af den samlede Luftmængde, da den absolute Luftmængde varierer i meget stærkere Grad med Temperaturen end Luftens relative Sammensætning, og man vil saaledes ved at benytte denne Udtryksmaade opnaa at gjøre sig i betydeligt større Udstrækning uafhængig af Temperaturens Indflydelse.

Ordner man de paa denne Maade udtrykte Tal efter Dybden, viser det sig, at der med Hensyn paa Surstofprocentens Størrelse i de forskjellige Dyb existerer en temmelig udpræget Lovmæssighed, som nærmere kan karakteriseres af nedenstaaende Tabel, der er uddraget af samtlige Observationer, naar undtages de to, hvor Udkogningen ikke foretoges strax men først efter nogen Tids Henstand.

Dybdeintervaller.		Antal Observationer.	Midlere Dybde.		Midlere Surstof-procent.
Engelske Favne.	Meter.		Engelske Favne.	Meter.	
0	0	28	0	0	35.31
0—100	0—183	6	69	126	33.93
100—300	183—549	14	210	384	32.84
300—600	549—1097	16	420	768	32.50
600—1000	1097—1829	11	684	1251	32.58
1000—1400	1829—2560	6	1192	2180	32.78
1400—1760	2560—3219	10	1646	3010	32.89

De enkelte Observationers Afvigelser fra den ved denne Tabel bestemte Regel ere i Betragtning af det undersøgte Felts store Udstrækning hverken mange eller synderlig store, idet kun 10, No. 2, 19, 38, 49, 64, 68, 83,

$$O = 7.79 - 0.2\,t + 0.005\,t^2,$$

giving 7.79 6.92 6.29
in place of the values observed . 7.77 6.93 6.29

Hence, the relative composition of the air absorbed is not, as Bunsen found to be the case with distilled water, independent of temperature, but varies with that factor, the percentage of oxygen, for instance, differing as much as 1 per cent between 0° and 15°.

Now, assuming the results of these experiments to furnish a normal standard, the relatively large proportion of oxygen as compared with the total amount of air present in the surface-water of the northern tracts of the sea investigated, will be found to arise from supersaturation with oxygen, and not, as might be supposed, from imperfect saturation with nitrogen, seeing that the proportion of oxygen exceeded that computed from these experiments by as much as, or even more than, 0.5^{cc}; for a difference so considerable does not admit of being ascribed to errors of observation. On the basis of these facts, the proportion of oxygen in surface-water is shown to depend not only on pressure and temperature, but, probably, also on the effect of one or more causes as yet unknown.

When investigating the degree in which the proportion of oxygen varies with the depth, it will be most convenient to express the difference as a percentage of the total amount of air, the absolute amount of air varying to a much greater extent with the temperature than does its relative composition; besides, with this mode of expression considerably less regard need be had to the influence of temperature.

If the figures representing the results thus expressed are arranged according to depth, the proportion of oxygen present in the different strata will be found to exhibit very considerable uniformity, as appears from the following Table, based as it is on the whole series of determinations, with the exception of two, the water with which the latter were performed not having been boiled at once, but allowed to stand over for some time previous to examination.

Intervals of Depth.		Number of Observations.	Mean Depth.		Mean Percentage of Oxygen.
English Fathoms.	Metres.		English Fathoms.	Metres.	
0	0	28	0	0	35.31
0—100	0—183	6	69	126	33.93
100—300	183—549	14	210	384	32.84
300—600	549—1097	16	420	768	32.50
600—1000	1097—1829	11	684	1251	32.58
1000—1400	1829—2560	6	1192	2180	32.78
1400—1760	2650—3219	10	1646	3010	32.89

Considering the great extent of the region investigated, the deviation of the individual observations from the standard given in this Table is neither frequent nor considerable, 10 only, viz. Nos. 2, 19, 38, 49, 64, 68, 83, 84,

84, 85 og 87, fjerne sig om mere end 1 Procent fra det almindelige Resultat, medens man af samtlige Observationer kan bestemme en enkelt Observations sandsynlige Afvigelse fra den efter denne Tabel optrukne Curve til $\pm$ 0.52 %, en Afvigelse saa liden, at en ikke ringe Del af den kan skrives paa Observationsfeil.

De største Uoverensstemmelser optræde talrigst i et Dyb fra 300—600 Favne (549—1097 Meter) men findes ogsaa enkeltvis i større Dyb.

Fra Bunden hidrører i de større Dyb kun to Luftprøver med væsentlig for høi Surstofprocent nemlig No. 68 og 87, optagne fra to Puncter, som mærkeligt nok begge ligge paa en Linie paralel med og tæt ved Grændsen mellem den nordover strygende varme Strøm og den sydover forbi Jan Mayen gaaende Polarstrøm. Bortser man imidlertid fra disse de væsentligste Uoverensstemmelser, som bidrage til at give Curven et om end meget svagt Minimum i 300—400 Favnes (549—732 Meters) Dyb, vil man i Korthed kunne udtale Regelen for Surstofprocentens Aftagen med Dybet saaledes: Surstofprocenten er i Overfladen gjennemsnitlig 35.3 og aftager derpaa først hurtigt senere langsommere til henimod 32.5 i 300 Favnes (549 Meters) Dyb, hvorfra den med stigende Dyb holder sig paa det Nærmeste constant. Det kan bemærkes, at af de her undersøgte Vandprøver 40 ere øste lige ved Havbunden. Man vil imidlertid forgjæves bestræbe sig for at opdage nogen Forskjellighed i Egenskaber mellem disse og de fra ligestore intermediære Dyb optagne.

Hvor det gjælder at studere Variationerne af den absolute Luftmængde, maa det synes naturligt som Maal for denne at benytte den opløste Kvælstof, idet den observerede Luftmængde paa Grund af det vedvarende Forbrug af Surstof i de dybere liggende Lag bestandig kan forudsættes at være mere eller mindre forskjellig fra den Mængde, som vilde absorberes i Overfladen under directe Paavirkning af Atmosphæren. Kvælstofmængden kan derimod paa Grund af denne Gasarts stærkt udprægede Indifferentisme ligeoverfor andre Legemer uden synderlig Feil antages uafhængig af locale Tilfældigheder.

Anvendes saaledes Kvælstofmængden som Maal for den i Søvandet opløste Luft, viser der sig i Fordelingen ogsaa her en udpræget Lovmæssighed, naar undtages, at der i de af Svendsen paa det første Togt udførte Observationer overalt er fundet en mindre Kvælstofmængde, end man efter alle øvrige foreliggende Observationer skulde vente. Bortser man imidlertid fra disse paa første Togt udførte 14 Observationer, vil man se, at alle de Øvrige paa faa Undtagelser nær meget vel stemme overens med de Tal, man kan beregne efter den ved de ovenciterede Forsøg bestemte Formel

$$N = 14.4 - 0.23\, t.$$

85, and 87 exhibiting a difference of more than 1 per cent as compared with the general result, whereas the probable deviation of a single observation from the curve drawn according to this Table may be computed at $\pm$ 0.52 per cent, a deviation so small as to arise, probably, in no slight degree from errors of observation.

The greatest discrepancies refer chiefly to a depth of 300—600 fathoms (549—1097 metres); now and again, however, they were met with in water obtained from greater depths.

In only two of the samples of air expelled from bottom-water drawn where the depth was great, did the percentage of oxygen prove much too high, viz. in Nos. 68 and 87, the samples of water yielding them having been obtained from two spots which, strange to say, are in a line running parallel and in close proximity to the boundary between the warm current flowing north and the cold Arctic current flowing south past the Island of Jan Mayen. Now, if we exclude from these differences the chief of those that contribute towards giving the curve a very slight but appreciable minimum at a depth of from 300 to 400 fathoms (540—732 metres), the rule according to which the proportion of oxygen is found to diminish with the depth may be expressed as follows: — The proportion of oxygen, which at the surface is 35.3 per cent, begins at once and continues to diminish, at first rapidly and afterwards at a slower rate, till it has reached 32.5 per cent, at the depth of 300 fathoms (549 metres), from whence it keeps almost constant. I will not omit to observe, that of the samples of water examined 40 had been drawn from the bottom; is was, however, impossible to detect any difference in composition between these and the samples obtained from equal intermediate depths.

When investigating the variation in the absolute amount of air, it will obviously be advisable to make use of the nitrogen absorbed, since the quantity of air observed in the deeper strata may, by reason of the steady consumption of oxygen, be assumed to differ more or less from that which would be absorbed at the surface under the direct influence of the atmosphere, whereas nitrogen, from the very slight affinity evinced by that gas for other bodies, may, without involving appreciable error, be regarded as proof against the accidents of locality.

If, therefore, the amount of nitrogen be adopted as the standard of measurement for the air absorbed in seawater, a marked uniformity will here, too, be found to characterise the distribution, as determined by the observations described, with the exception however of Svendsen's, on the first voyage, by which the amount of nitrogen was found to be less than all subsequently instituted observations gave reason to expect. Excluding, then, the 14 observations from the first voyage, all of the others, with but few exceptions, agree closely with the figures which may be found by the formula stated above —

$$N = 14.4 - 0.23\, t.$$

Man faar nemlig af Observationerne følgende Middelværdier:

Dybdeintervaller. Engelske Favne.	Meter.	Middeltemp. ° C.	Midlere Kvælstofmængde observeret	Kvælstofmængde beregnet.	Differents.
0	0	6.4	13.07	12.93	—0.14
0—100	0—183	2.7	13.98	13.78	—0.20
100—300	183—549	1.0	14.15	14.17	0.02
300—600	549—1097	—0.6	14.54	14.54	0.00
600—1000	1097—1829	—0.8	14.04	14.58	0.54
1000—1760	1829—3219	—1.4	14.38	14.72	0.34

Naar den midlere Kvælstofmængde her i de dybere Lag er funden noget lavere end man skulde vente, da har dette sin Grund i, at der ved de 5 Observationer No. 17, 22, 33, 36 og 37, alle hidrørende fra Vandprøver fra det i 1877 undersøgte Strøg, er fundet en ca. 1.5 CC. lavere Gehalt, end de ved sin Temperatur vilde kunne optage ved almindeligt Atmosphæretryk. Forresten vil efter alle de øvrige Observationer at dømme ogsaa i de større Dyb Kvælstofmængden findes at stemme overens med den af Formelen beregnede.

En lignende Sammenligning[1] er af Buchanan gjort mellem de af ham for de sydlige Have fundne Tal og de af Bunsen for destilleret Vand opstillede. Der optræder ved denne Sammenligning især ved de lavere Temperaturer ikke ubetydelige Differentser paa lige op til over 1 CC. pr. Litre, men disse vil ved Sammenligning med de efter Forfatterens Formel beregnede Tal saa godt som bortfalde, idet man faar:

Dybde i Fod.	Midlere Temperatur. ° C.	Kvælstofmængde efter Buchanan.	Kvælstofmængde efter Formelen.	Differents.
600	14.6	11.26	11.04	—0.22
1200	13.0	11.71	11.41	—0.30
1800	6.9	13.00	12.81	—0.19
2400	5.1	13.10	13.23	0.13
4800	2.5	13.82	13.82	0.00
derover	1.5	14.37	14.05	—0.32

Det fremgaar heraf, at Kvælstofmængden, saaledes som det allerede af Dr. Jacobsen og Andre er antaget, ikke i mindste Maade retter sig efter de i de store Dyb herskende Tryk men kun afhænger af Temperaturen. Den eneste rimelige Fortolkning udelukker Muligheden for, at Tryk- og Temperaturdifferentser i de under Overfladen

[1] Ber. Berl. chem. Ges. — 11 — 410.

as will be seen from the following Table showing the mean values.

Intervals of Depth. English Fathoms.	Metres.	Mean Temp. ° C.	Mean Amount of Nitr. observed.	Amount of Nitrogen computed.	Difference.
0	0	6.4	13.07	12.93	—0.14
0—100	0—183	2.7	13.98	13.78	—0.20
100—300	183—549	1.0	14.15	14.17	0 02
300—600	549—1097	—0.6	14.54	14.54	0.00
600—1000	1097—1829	—0.8	14.04	14.58	0.54
1000—1760	1829—3219	—1.4	14.38	14.72	0.34

The mean quantity of nitrogen in the deeper strata proved, accordingly, somewhat lower than there was reason to expect; but this arose from the proportion determined by 5 of the observations, viz. Nos. 17, 22, 33, 36, and 37 — all of them referring to samples of water obtained from the tract of ocean investigated in 1877 — having been about 1.5^{cc} less than could be absorbed at the same temperature under ordinary atmospheric pressure. For the rest, judging from all the other observations, the proportion of nitrogen observed, even at greater depths, will be found to agree with that computed by the formula.

A similar comparison[1] was instituted by Buchanan between his results for the water of the Southern Seas and the figures found by Bunsen for distilled water. The differences resulting from this comparison, more especially for a low temperature, are considerable, the greatest reaching 1^{cc} per litre; but, on comparing them with the figures given by the author's formula, they will be found almost to vanish, as appears from the following Table.

Depth in Feet.	Mean Temperature. ° C.	Amount of Nitrogen accord. to Buchanan.	Amount of Nitrogen comp. by the Formula.	Difference.
600	14.6	11.26	11.04	—0.22
1200	13.0	11.71	11.41	—0.30
1800	6.9	13.00	12.81	—0.19
2400	5.1	13.10	13.23	0.13
4800	2.5	13.82	13.82	0.00
Greater Depths.	1.5	14.37	14.05	—0.32

Hence the amount of nitrogen, as previously assumed by Dr. Jacobsen and others, can in no wise be affected by the increase of pressure at great depths, but must obviously be dependent on temperature alone. The results of these observations exclude, therefore, the possibility of differences in temperature and pressure at depths below

[1] Ber. Berl. chem. Ges. 11, p. 410.

liggende Lag skulde kunne hidføre en anden Fordeling af Luften end den, der allerede existerer fra den Tid, da Vandet sidste Gang befandt sig i Overfladen udsat for fri Paavirkning af Atmosphæren. Luften vil saaledes kun gjennem Vandets Circulation kunne naa ned i Dybet, og nogen Udjevning af Luftmængderne vil der kun kunne ske gjennem Blanding af de forskjelligartede Vandmængder, en Blanding, som under Forudsætning af at der ikke ogsaa foregaar Opvarmning eller Afkjøling, ikke vil kunne forrykke det rette Forhold mellem Temperatur og Kvælstofmængde, da Kvælstofmængdens Variation med Temperaturen fremstilles ved en ret Linie.

Man vil altsaa, dersom disse Forudsætninger holde Stik, ved en Kvælstofbestemmelse i de dybere liggende Vandlag kunne om end meget raat bestemme, om disse have været Gjenstand for en væsentlig Opvarmning eller Afkjøling, siden de sidst befandt sig i Overfladen, forudsat at man kan negligere Virkningerne af Atmosphæretrykkets Forandringer og andre mulige Tilfældigheder, som under Absorbtionen i Overfladen vil kunne gjøre sin Indflydelse gjældende.

Grupperer man de her offentliggjorte Observationer efter Vandprovernes Temperatur, viser det sig, at Kvælstofmængden meget noie svarer til den efter denne Temperatur af Formelen beregnede, det vil sige, Vandprovernes Temperatur skulde ikke i væsentlig Grad have forandret sig, siden de sidst befandt sig i Overfladen. Man faar nemlig:

Temperatur-interval.	Midlere Temperatur.	Midlere Kvælstof-mængde.	Beregnet Kvælstof-mængde.	Differents.
under 0°	—1°.1	14.32	14.65	0.33
0—3	1.2	14.19	14.12	—0.07
3—6	4.6	13.38	13.34	—0.04
6—9	7.5	12.90	12.67	—0.13
over 9	11.2	11.93	11.82	—0.11

At Overensstemmelsen for Temperaturerne under 0° ikke er saa fuldstændig som ellers, skyldes ogsaa her de ovenfor nævnte 5 Observationer alle udførte paa Togtet i 1877. Beregner man derimod den midlere Temperatur og Kvælstofmængde for dette Interval af de paa sidste Aars Togt gjorte Observationer, erholder man til Middeltemperaturen —1.2 Kvælstofmængden 14.59 CC. altsaa kun 0.09 CC. mindre end beregnet.

Benyttes paa samme Maade de af Dr. Jacobsen offentligjorte Observationer til et Overslag over Kvælstofmængden i Nordsoen, erholder man med runde Tal:

the surface causing a distribution of the air different to that which existed when the water was last at the surface, in direct contact with the atmosphere. Hence the air cannot penetrate to such depths save by the circulation of the water, and an adjustment of the amounts of air can be effected solely by the mixing of the water different in composition, which will not, however, unless we assume a simultaneous increase or decrease of heat, disturb the true relation between the temperature and the amount of nitrogen, since the variation of the latter with the temperature is expressed by a right line.

If, then, these assumptions are found to hold good, it will be possible, when computing the proportion of nitrogen in the lower strata of the water, to determine — very roughly indeed — whether the latter have experienced any increase or decrease of heat since they were last at the surface, provided we can ignore the effect of change in the atmospheric pressure and of other accidental circumstances, which, during the process of absorption, may have made their influence felt.

On grouping together according to the temperature of the samples of water examined, the observations published in this Memoir, the proportion of nitrogen will be found to agree very closely with that computed by the formula, showing, as appears from the following Table, that the temperature could have varied but little since the water had been last at the surface.

Intervals of Temperature.	Mean Temperature.	Mean Amount of Nitrogen.	Computed Amount of Nitrogen.	Difference.
below 0°	—1°.1	14.32	14.65	0.33
0—3	1.2	14.19	14.12	—0.07
3—6	4.6	13.38	13.34	—0.04
6—9	7.5	12.90	12.67	—0.13
above 9	11.2	11.93	11.82	—0.11

For the temperatures under 0° the agreement is indeed not so close; but here, too, the cause may be traced to the aforesaid 5 observations from the voyage in 1877. If, however, we compute the mean temperature and the amount of nitrogen for that interval by the results of the observations instituted on the last voyage, the mean temperature will be —1.2 and the amount of nitrogen 14.59cc, or only 0.09cc less than that computed by the formula.

A similar computation with the observations published by Dr. Jacobsen for estimating the amount of nitrogen in the water of the North Sea, will give, in round numbers, the following results: —

Temperatur-interval.	Midlere Temperatur.	Midlere Kvælstof-mængde.	Beregnet Kvælstof-mængde.	Differents.
under 10°	6°.5	13.2	12.9	—0.3
10—15	12 .1	12.0	11.6	—0.4
15—20	16 .9	11.0	10.5[1]	—0.5

Her findes altsaa overalt en Kvælstofgehalt svarende til en noget lavere Temperatur end den observerede og det i stærkest Grad for de høiere Temperaturer, eller da Temperaturen aftager med Dybden, for de øverst liggende Vandlag. Naar man erindrer, at Jacobsens Observationer ere udførte i Eftersommeren og for det Meste paa Vandprøver fra saa smaa Dyb, at Luft- og Vandtemperaturens aarlige Variation kan tænkes at have gjort sig gjældende, vil dette ikke være saa vanskeligt at forklare gjennem Vandets Opvarmning i Sommermaanederne, medens Kvælstofmængden maa antages at rette sig efter en Temperatur mindst lige saa lav som den aarlige Middeltemperatur.

At lignende Phænomener ikke ogsaa ere observerede i de øvre Lag af det af den norske Nordhavsexpedition undersøgte Hav, har sin simple Forklaringsgrund deri, at Lufttemperaturen der selv om Sommeren ikke er høiere end Overfladetemperaturen hellere omvendt.

[1] Den for Intervallet fra 0 til 15° udledede Formel er her forudsat at gjælde ogsaa fra 15 til 20°.

Intervals of Temperature.	Mean Temperature.	Mean Amount of Nitrogen.	Computed Amount of Nitrogen.	Difference.
below 10°	6°.5	13.2	12.9	—0.3
10—15	12 .1	12.0	11.6	—0.4
15—20	16 .9	11.0	10.5[1]	—0.5

The proportion of nitrogen in this Table corresponds accordingly to a somewhat lower temperature than that observed, especially for the higher temperatures, or rather, since the temperature diminishes with the depth, for the upper strata of the water. If, however, we bear in mind that Jacobsen's observations were instituted at the latter end of summer, and the majority with samples of water obtained from such trifling depths that the annual variation in the temperature of air and water probably exerted some influence, this will not be difficult to account for, by reason of the heat stored in the water during the summer months, whereas the amount of nitrogen must be regulated by a temperature at least as low as the mean annual temperature.

That similar phenomena were not observed in the upper strata of the water throughout the tract of ocean investigated on the Norwegian North-Atlantic Expedition, arises simply from the fact, that the temperature of the air in those regions does not even in summer exceed that of the water at the surface, nay the reverse is rather the case.

[1] The formula deduced for the interval from 0° to 15° is here assumed to be correct for that extending from 15° to 20°.

II. Om Kulsyren i Søvandet.

Af alle de Chemikere, som for den tyske Pomerania-expedition i 1872 anstillede Undersøgelser over Luften i Søvandet, blev der foruden Bestemmelser af Surstof-Kvælstofmængden ogsaa samtidig udført Maalinger af den under Udkogningen uddrevne Kulsyre, og de Qvantiteter, man paa denne Maade fandt, bleve ogsaa bestandig opførte blandt Resultaterne som den samlede Mængde Kulsyre, der var opløst i Søvandet enten fri som Gasart eller bunden til Carbonater som sure Salte. De Resultater, som ad denne Vei erholdtes, vise imidlertid bestandig overmaade store Uoverensstemmelser ikke alene mellem de forskjellige Forfattere men ogsaa mellem de enkelte Observationer hos en og samme Experimentator, hvor man dog maatte have antaget, at en større Ensartethed i Forsøgenes Udførelse skulde have udjevnet Differentserne.

Som Exempel paa, hvor vidt Uoverensstemmelserne i de ældre Opgaver strække sig, kan anføres Følgende:

I en Liter Overfladevand fandt

Frémy	2.2 til 2.8	CC. Kulsyre	[1].
Morren	1.6 „ 3.9	— —	[2].
Lewy	2.4 „ 3.9	— —	[3].
Pisani	6.0 „ 8.1	— —	[4].
Hunter	0.8 „ 5.9	— —	[5].

Desuden fandtes efter en noget anden Fremgangsmaade af

Bischof	39.0 CC.	[6].
Vogel	55.6 til 116.3	[7].

Ved alle disse ældre Undersøgelser, hvor der ved Udkogningerne var anvendt fuldt Atmosphæretryk, og hvor

[1] Compt. rend. 6—616.
[2] Ann. Chim. Phys. 3] — 12 — 5.
[3] Ann. - — [3] — 17. Ann. Chem. Pharm. 58 — 328.
[4] Compt. rend. 41 — 532.
[5] Jahresbericht 1869 — 1279.
[6] Chem. Geologie 1 Aufl. 2 - 1130.
[7] Schweigg. Journ. 8 — 351.

II. On the Carbonic Acid in Sea-water.

The several chemists who, previous to the German 'Pomerania' Expedition (1872), had instituted observations on the air present in sea-water, when measuring the amount of the oxygen and nitrogen also collected the carbonic acid driven off during the process of boiling; and the quantities determined were invariably set down among the results as the total amount of carbonic acid actually existing in the water, either free as gas or contained, to a less extent, also in bicarbonates. The results thus attained vary however to a remarkable extent, and not only as between the different experimentalists individually, — the like is also the case with the observations of one and the same person, although greater uniformity in the mode of operation should apparently have tended to eliminate error.

The following Table will show the wide difference prevailing between the formulæ of early authors.

Amount of Carbonic Acid in 1 Litre of Surface-water.

Frémy	2.2 to 2.8 CC.	[1].
Morren	1.6 „ 3.9 —	[2].
Lewy	2.4 „ 3.9 —	[3].
Pisani	6.0 „ 8.1 —	[4].
Hunter	0.8 „ 5.9 —	[5].

The proportion as found by a somewhat different process was as follows —

Bischof	39.0 CC.	[6].
Vogel	55.6 to 116.3 —	[7].

Hence, it appears that the quantity of carbonic acid given off under these early experiments, for which the boil-

[1] Compt. rend. 6, p. 616.
[2] Ann. Chim. Phys. 3 12, p. 5.
[3] - [3] 17. Ann. Chem. Pharm. 58, p. 328.
[4] Compt. rend. 41, p. 532.
[5] Liebigs Jahrbericht 1869, p. 1279.
[6] Chem. Geologie 1 Aufl. 2, p. 1130.
[7] Schweigg. Journ. 8, p. 351.

derfor Temperaturen steg over 100°, undveg altsaa altid vel maalelige og ofte endog temmelig betydelige Mængder Kulsyre.

Ved de paa Pomeraniaexpeditionen i 1871 udførte Luftbestemmelser [1], hvor den tidligere beskrevne Methode med Gasarternes Udkogning under et ved Vanddamp frembragt Vacuum anvendtes, sænkedes imidlertid Temperaturen ikke ubetydeligt, og det viste sig da, at man ved denne Temperatur temmelig ofte kun fik næsten umaalelig smaa Qvantiteter Kulsyre uddrevet sammen med den øvrige Luft, medens de tidligere Uoverensstemmelser mellem flere med samme Vandprøve gjentagne Udkogninger ogsaa her gik igjen.

Jacobsen fandt sig derfor ved dette mærkelige Phænomen foranlediget til nærmere at andersøge Kulsyrens Absorbtionsforhold ligeoverfor Søvand.

Gjennem de Forsøg, som han i denne Anledning anstillede, viste det sig da, at man ad andre Veie kunde paavise aldeles uventet store Qvantiteter Kulsyre i det samme Vand, hvoraf man ved en i flere Timer fortsat Udkogning efter Bunsens Methode kun kunde erholde meget smaa Mængder. Afdestilleredes nemlig Søvandet i en kulsyrefri Luftstrøm uden Luftfortynding i en Retorte, undveg der den hele Tid Kulsyre, lige indtil den hele Mængde Vædske var afdestilleret, saaledes at man først ved rigelig Udskillelse af Salte kunde være fuldstændig sikker paa at have erholdt det samlede Udbytte af Kulsyre uddrevet.

Der lod sig under Udkogningen ikke paavise noget Punct, hvor man kunde tale om en Grændse mellem fri og surt bunden Kulsyre.

Paa denne Maade uddrev nu Jacobsen ved fuldstændig Afdestillation af $^1/_4$ Litre Søvand i en kulsyrefri Luftstrøm den hele Mængde Kulsyre og opsamlede den efter Pettenkoffers Princip i en afmaalt Mængde titreret Barytvand, som efter endt Operation retitreredes med Oxalsyre, og beregnedes efter disse den samlede Kulsyremængde, som for ufortyndet Nordsøvand opgives til omkring 100 Mgr. per Litre.

Samtidig bestemtes ogsaa i Residuet fra Inddampning af circa 10 Litre af det samme Vand den i de neutrale Carbonater indeholdte Kulsyre til i Middel kun omkring 10 Mgr. per Litre.

Ifølge disse Observationer kunde altsaa kun en meget liden Brøkdel af den ved Destillationen uddrevne Kulsyre betragtes som surt bunden, og Jacobsen imødegaar derfor i sin Afhandling bestemt den af Vierthaler [2] gjorte Antagelse, at al den ved Kogning af Søvandet uddrevne Kulsyre skulde være surt bunden. Han anser sig endvidere aldeles sikker for under Inddampningen ikke at have erholdt decomponeret nogen Del af de i Søvandet indeholdte neutrale Carbonater, idet han udtrykkelig siger: "Die ganze Menge der nicht

[1] Ann. Chem. Pharm. 167 — 1.
[2] Wien. Acad. Ber. [2] — 56 — 479.

ing-process was conducted with full atmospheric pressure, or at a temperature of more than 100° C., invariably proved appreciable, nay sometimes rather large.

When performing the air-determinations [1] on the 'Pomerania' Expedition in 1871 (by the method, previously described, of boiling out the gaseous elements in a vacuum created by steam), the temperature kept considerably lower, and the quantity of carbonic acid expelled with the other atmospheric elements at a comparatively low temperature was often immeasurably small; moreover, the variable character of the results, alluded to above, on repeating the boiling-process with the same sample of water again asserted itself.

Struck by this remarkable phenomenon, Jacobsen determined to investigate anew the absorptive capacity of sea-water in relation to carbonic acid.

The experiments of that chemist undertaken with the above object in view afforded conclusive proof of the fact, that large quantities of carbonic acid were still present in water from which a very small amount only could be expelled after several hours' protracted boiling by Bunsen's method. On distilling in a retort sea-water exposed to a current of air free from carbonic acid, but not rarified, carbonic acid is found to escape so long as any portion of the fluid remains undistilled, an abundance of solid deposit however being the only indication that all or nearly all the carbonic acid present in the water has been driven off.

During the process of boiling no particular moment could be determined marking the escape of the carbonic acid present as gas and of that which has combined with carbonates to form bicarbonates.

In this manner, by distillation in a current of air free from carbonic acid, Jacobsen succeeded in expelling the whole amount of carbonic acid contained in $^1/_4$ litre of sea-water, and collected it, by Pettenkoffer's method, in a given quantity of titrated baryta water of known strength, which, on the operation being terminated, he retitrated with oxalic acid, computing accordingly the total amount of carbonic acid driven off in the process. Undiluted North Sea water contains according to Jacobsen's results about 100^{mgr} per litre.

The amount of carbonic acid contained by the neutral carbonates in the residuary deposit from the evaporation of 10 litres of the same water, was also calculated, and found to average only about 10^{mgr} per litre.

According to these observations, a very small proportion only of the carbonic acid driven off by distillation could have been present in bicarbonates; and hence Jacobsen emphatically opposes Vierthaler's assumption, [2] that the carbonic acid boiled out of sea-water occurs in that form. Moreover, he feels quite sure that no portion of the neutral carbonates in the water examined was decomposed during the process of boiling. "Die ganze Menge," he says, "der nicht mit Basen zu neutralen Salzen verbun-

[1] Ann. Chem. Pharm. 167, p. 1.
[2] Wien. Acad. Ber. [2] 56, p. 479.

mit Basen zu neutralen Salzen verbundenen Kohlensäure erhält man aus dem Meerwasser, wenn dieses unter Durchleiten eines Stromes kohlensäurefreier Luft bis zur reichlichen Abscheidung von Chlornatrium verkocht wird."

Det maatte saaledes fremstille sig som et høist mærkeligt Phænomen, at den Kulsyre, som dog maatte tænkes opløst i Søvandet paa en eller anden Maade som fri Gasart, ikke skulde lade sig uddrive ved Udkogning efter Bunsens Methode, og at den endogsaa ved Udkogning under fuldt Atmosphæretryk og i en kulsyrefri Luftstrøm skulde undvige saa langsomt, at man først ved Concentration til omkring $^1/_{10}$ af det oprindelige Volum erholdt den sidste Rest uddrevet

Forat kunne forklare disse Mærkeligheder tillægger Jacobsen Søvandet en eiendommelig Evne til med megen Kraft at kunne tilbageholde sin Kulsyre, en Mening, som han efter nærmere at have fremført sine Grunde mod den af Vierthaler gjorte Antagelse udtrykker med følgende Ord: "Wie man aber auch eine Deutung der starken Absorptionswirkung des Meerwassers auf die atmosphärische Kohlensäure versuchen möge, jedenfalls kann man die Kohlensäure nicht in demselben Sinne, wie Sauerstoff und Stickstoff, als absorbirtes freies Gas darin annehmen. Man mag einstweilen von einem eigenthümlichen Zustande der Bindung sprechen, bei welchem die Kohlensäure selbst durch stundenlanges Kochen nur sehr unvollständig ausgestrieben wird. Das Vorhandensein ungeheuerer Mengen Kohlensäure im Meerwasser, in einem solchen Zustande, wo sie der Athmungsluft der Seethiere nicht ohne Weiteres zugezählt werden kann, ohne andererseits der Vegetation des Meeres unzugänglich zu sein, ist jedenfalls für das maritime Thier- und Pflanzenleben von höchster Bedeutung."

Jacobsen antager nærmest at maatte henlægge denne eiendommelige Absorbtionsevne hos Søvandet til den deri opløste Chlormagnesium og henviser i saa Henseende til Egenskaber hos en Chlormagnesiumopløsning, der indeholder en i Kulsyre opløst Mængde kulsur Kalk. En saadan Opløsning kan ifølge ham henstaa i ugevis ja endog koges uden at blakkes, først ved meget langt fortsat Concentration udskiller der sig ren kulsur Magnesia.

Denne Jacobsens Anskuelsesmaade blev senere saa godt som uforandret optagen af den engelske Challenger-expeditions Chemiker, J. Y. Buchanan, som udførte en Række Forsøg[1] for nærmere at bestemme, hvilket eller hvilke af Saltene i Søvandet der skulde være i Besiddelse af denne Evne saaledes at kunne tilbageholde Kulsyren. Han kom i den Henseende til det paafaldende Resultat, at de fleste Salte, som han undersøgte, i mere eller mindre Grad skulde være i Besiddelse af denne Egenskab dog mest Sulfaterne, saaledes at denne Søvandets stærke Absorbtionsevne ligeoverfor Kulsyren af ham henlagdes fra Chlormagnesium til Sulfaterne. Ved de af ham udførte

[1] Proc. Royal Soc. 22 — 192 og 483.

denen Kohlensäure erhält man aus dem Meerwasser, wenn dieses unter Durchleiten eines Stromes kohlensäurefreier Luft bis zur reichlichen Abscheidung von Chlornatrium verkocht wird."

Hence it could not but strike the experimentalist as a remarkable phenomenon, that the carbonic acid, which in some way or other must have been held absorbed by the sea-water in a free gaseous form, should not admit of being boiled out by Bunsen's method, and that even when the boiling-process was conducted with full atmospheric pressure in a current of air free from carbonic acid, it should escape so slowly, that concentration to the extent of about one-tenth of the original volume proved necessary to obtain it all.

To account for this perplexing phenomenon, Jacobsen ascribed to sea-water a peculiar property of retaining its carbonic acid, an assumption which, after setting forth more at large the grounds that led him to oppose Vierthaler's hypothesis, he enounces in the following terms: — "Wie man aber auch eine Deutung der starken Absorptionswirkung des Meerwassers auf die atmosphärische Kohlensäure versuchen möge, jedenfalls kann man die Kohlensäure nicht in demselben Sinne, wie Sauerstoff und Stickstoff, als absorbirtes freies Gas darin annehmen. Man mag einstweilen von einem eigenthümlichen Zustande der Bindung sprechen, bei welchem die Kohlensäure selbst durch stundenlanges Kochen nur sehr unvollständig ausgestrieben wird. Das Vorhandensein ungeheuerer Mengen Kohlensäure im Meerwasser, in einem solchen Zustande, wo sie der Athmungsluft der Seethiere nicht ohne Weiteres zugezählt werden kann, ohne andererseits der Vegetation des Meeres unzugänglich zu sein, ist jedenfalls für das maritime Thier- und Pflanzenleben von höchster Bedeutung."

Jacobsen is of opinion, that this peculair absorptive power must be derived from the chloride of magnesia present in sea-water, and draws attention to certain properties possessed by a solution of chloride of magnesia containing carbonate of lime dissolved in carbonic acid. A solution of this kind may, according to his statement, be left exposed for weeks together, nay be boiled even, without becoming turbid; nor can it be made to part with pure carbonate of magnesia till after protracted concentration.

Jacobsen's hypothesis was subsequently adopted, almost without modification, by J. Y. Buchanan, chemist to the 'Challenger' Expedition, who instituted a series of experiments[1] with a view to determine which of the salts present in sea-water had this property of retaining carbonic acid. He arrived at the surprising conclusion, that most of the salts examined were in some degree distinguished by this property, chiefly however the sulphates; and the remarkable power possessed by sea-water of retaining carbonic acid he transferred accordingly from chloride of magnesia to the sulphates. Hence, when performing carbonic acid determinations he always precipitated the sulphuric

[1] Proc. Royal Soc. 22, pp. 192 and 483.

Kulsyrebestemmelser pleiede han derfor altid for Operationens Begyndelse at udfælde Svovlsyren med concentreret Chlorbariumoplosning, forat Kulsyren lettere skulde undvige, men anvendte forresten den af Dr. Jacobsen angivne Methode, hvorved han har bestemt Kulsyren i Sovandet i de sydlige Have til i Middel 43.26 Mgr. per Litre[1].

Da jeg Vaaren 1877 opfordredes til at gaa ud som Chemiker paa den norske Nordhavsexpeditions 2det Togt, var der kun levnet mig nogle faa Dage til Forberedelser, og det følger derfor af sig selv, at jeg ikke paa nogen Maade dengang kunde have befattet mig med vidtløftigere Forundersøgelser, og jeg maatte saaledes uden selv at kunne prøve optage de tidligere Methoder uforandrede. Paa Togtet i 1877 anvendtes derfor den af Dr. Jacobsen angivne Methode, og bestemtes efter denne gjennem en Række omhyggelig udførte Observationer Kulsyregehalten i det da undersøgte Hav til omkring 100 Mgr. per Litre. Der viste sig imidlertid ved Gjentagelse af samme Observation bestandig Uoverensstemmelser, som ofte vare ikke ubetydelige og engang endog løb op til hele 12 Mgr. per Litre.

Dels herved dels ved andre Omstændigheder vaktes min Mistanke om Tilforladeligheden af den af Dr. Jacobsen i Forslag bragte Methode.

Det syntes mig paa Forhaand overmaade urimeligt, at der hos Søvandet skulde findes en saadan mærkelig Evne til rent mekanisk at tilbageholde den ene Gasart, medens den ingensomhelst Virkning skulde udøve paa de Andre. Heller ikke var der nogensinde gjort noget Forsøg paa at sætte dette Phænomen i Forbindelse med bekjendte chemiske Egenskaber hos nogen af de i Søvandet indeholdte Stoffe.

Ved et Tilfælde kom jeg en Dag til at forsoge Søvandets Reaktion paa Lakmus og Rosolsyre og fandt til min store Forundring, at det reagerede bestemt og tydeligt alkalisk, hvad jeg siden har bragt i Erfaring, at allerede v. Bibra[2] og senere E. Guignet og A. Telles[3] har observeret.

Efter mine Forsøg viser to ligestore Prøver af en efter Gottliebs[4] Fremgangmaade frisk tilberedt Lakmusopløsning, hvoraf den Ene tilsættes en tilstrækkelig Mængde Søvand og den Anden et ligestort Volum rent destilleret Vand, ikke ubetydelige Farvedifferentser. Ligeledes antager en med meget fortyndet Oxalsyre svagt udsyret passende Portion rent Vand, hvori paa Forhaand er opløst en Draabe Rosolsyre, ved Tilsætning af Søvand strax den bekjendte rødlig-violette Farve.

Paa denne Maade undersøgtes paa Expeditionens sidste Togt, hvor der var fuld Anledning til at erholde Vandprøverne ganske friske, et meget stort Antal af disse og uden Undtagelse med det samme ovenbeskrevne Resultat.

[1] Ber. Berl. chem. Ges. 11 — 410.
[2] Ann Chem. Pharm. 77 — 90.
[3] Compt. rend. 83 — 919.
[4] Journ. für pract. Chem. 107 — 488.

acid, before commencing the operation, by adding to the water a saturated solution of chloride of barium, in order to facilitate the liberation of the carbonic acid, but, with this exception, adopted the method devised by Dr. Jacobsen, and determined the mean amount of carbonic acid present in the water of the Southern Seas to be 43.26^{mgr} per litre.[1]

When invited, in the spring of 1877, to go out as chemist to the Norwegian North-Atlantic Expedition, on the second cruise, I had but a few days in which to make the necessary preparations, and consequently no time being left me for preliminary experiments, I was compelled to adopt unchanged the earlier methods, without testing the accuracy of their results. On the cruise in 1877, I therefore applied Dr. Jacobsen's method, and determined by a series of careful observations the amount of carbonic acid present in the water of the tract then investigated to be about 100^{mgr} per litre. But, on repeating the operation with the same sample of water, the results were always found to vary, and frequently indeed considerably; nay, on one occasion the difference amounted to as much as 12^{mgr} per litre.

Partly for this reason, and partly from other circumstances, I was led to question the trustworthiness of Jacobsen's method.

Now it struck me at once as highly improbable that sea-water should possess so remarkable a power of retaining mechanically one gas, and yet, in this respect, exert no influence whatever on others. Nor had any attempt been made to connect this phenomenon with known chemical properties distinguishing the substances contained in sea-water.

Quite accidentally, I was one day led to investigate the effect of sea-water as a reagent on litmus and rosolic acid, and found its reaction, to my great surprise, distinctly alkaline, which, indeed, as I subsequently learnt, had been already observed, first by von Bibra[2] and later by E. Guignet and A. Telles.[3]

According to my experiments, two equal measures of a solution of litmus, freshly prepared by Gottlieb's method,[4] one of which has added to it a sufficient quantity of sea-water and the other an equal volume of pure distilled water, exhibit considerable difference in colour. Moreover, a proportionate mixture of highly dilute oxalic acid and pure water, the latter having been previously treated with a drop of rosolic acid, will, on the addition of sea-water, immediately assume the well known reddish-violet hue.

In this manner were examined on the last cruise of the Expedition, which afforded excellent opportunities of obtaining the water quite fresh, a very large number of samples, and invariably with the results described above.

[1] Ber. Berl. chem. Ges. 11, p. 410.
[2] Ann. Chem. Pharm. 77, p. 90.
[3] Compt. rend. 83, p. 919.
[4] Journ. für pract. Chem. 107, p. 488.

Dette syntes ogsaa meget vanskeligt at forklare, saafremt det virkelig skulde forholde sig som af Enkelte paastaaet, at der i Søvandet skulde findes et meget stort Overskud af fri Kulsyre ved Siden af en meget liden Qvantitet af sure Carbonater. Det maatte aabenbart synes meget rimeligere at forklare de af Dr. Jacobsen gjorte Observationer derved, at Søvandet under den langvarige Kogning ved en eller anden chemisk Reaction gav Slip paa noget af sin neutralt bundne Kulsyre.

For at komme paa det Rene med, om dette virkelig forholdt sig saa, gik jeg frem paa følgende Maade:

200 CC. Søvand (af sp. Vægt 1.0267 ved 17.°5 C. i Forhold til destilleret Vand af samme Temperatur) afdestilleredes næsten til Tørhed i en kulsyrefri Luftstrøm, og opfangedes den undvigende Kulsyre i 25 CC. af en Barytopløsning, hvoraf 1 CC. svarede til 4.0204 Mgr. Kulsyre. Ved Retitration med Oxalsyre viste det sig, at 19.97 CC. af det anvendte Barytvand var uneutraliseret, hvoraf den undvegne Kulsyre beregnedes til 20.2 Mgr. Residuet paaheldtes nu friskt udkogt Vand, som atter afdestilleredes, hvorved endnu et ubetydeligt Spor af Kulsyre erholdtes. Sluttelig tilsattes circa 0.5 Gr. fuldkommen ren friskt udglødet Soda, hvorpaa det Hele atter fortyndedes med kulsyrefrit Vand til Søvandets oprindelige Volum og saa afdestilleredes i en kulsyrefri Luftstrøm.

Allerede fra det Øieblik af, da Vædsken var kommen i Kog, begyndte strax en saa voldsom Kulsyreudvikling, at det i Forlaget anbragte Barytvand slap store Mængder uabsorberede igjennem, og det viste sig efter endt Operation, at kun 1.3 CC. Barytvand var forblevet uneutraliseret. Heraf beregnes den absorberede Del af den undvegne Kulsyre til 95.3 Mgr., medens desforuden meget betydelige Mængder gik igjennem, idet nemlig Barytvandet i et uformigt Rør, som var anbragt foran Forlaget, fuldstændigt var forbrugt.

Efter Forslag af Professor Waage gjentoges Forsøget med varmt fældt, ved 100° tørret kulsur Kalk, hvoraf det ogsaa lykkedes at uddrive ikke ubetydelige om end meget mindre Mængder Kulsyre, hvorimod der ved et Forsøg med fint pulveriseret Marmor ikke erholdtes noget sikkert Resultat.

Betydningen af disse Observationer kunde ikke være tvivlsom, da det hermed paa det Tydeligste var godtgjort, at den i Søvandet forhaandenværende Saltblanding ved Koghede decomponerede neutrale Carbonater, og dermed ogsaa, at alle de hidindtil gjorte Kulsyrebestemmelser med Hensyn paa sin Hensigt at bestemme den i Søvandet indeholdte frie og surt bundne Kulsyre vare forfeilede. Hvad angaar de før Publicationen af Dr. Jacobsens Afhandling om Luften i Søvandet udførte Kulsyrebestemmelser, da er det en Selvfølge, at de alle uden Undtagelse maatte være i enhver Henseende fuldstændig værdiløse, idet der ved dem intetsteds er kommen til Anvendelse en Afdestillation til Tørhed eller en saa vidtdreven Concentration, at man

This fact would obviously be most difficult of explanation if, as some have affirmed, sea-water does actually contain a very large surplus of free carbonic acid along with an exceedingly small proportion of bicarbonates. A more plausible hypothesis by which to explain Dr. Jacobsen's observations were surely the assumption, that during the protracted process of boiling some of the neutral carbonates present in sea-water had been decomposed.

With the object of ascertaining whether such was really the case, I went to work as follows.

Two hundred c.centim. of sea-water (sp. grav. 1.0267, temp. 17.°5 C., as compared with distilled water of the same temperature) were distilled almost to dryness in a current of air free from carbonic acid, and the carbonic acid collected in 25^{cc} of baryta water, 1^{cc} of which represented 4.0204^{mgr} carbonic acid. On being retitrated with oxalic acid 19.97^{cc} of the baryta water were found not to be saturated, and 20.2^{mgr} carbonic acid had accordingly been driven off. Water freshly boiled was now poured on the residue, and then evaporated, the result yielding a slight trace of carbonic acid; finally, about 0.5^{mgr} purified and freshly heated soda was added, and the whole compound again diluted with water, from which all carbonic acid had been expelled, to the original volume of the sample, and then distilled in a current of air free from carbonic acid.

From the very moment at which the fluid began to boil, so rapid was the liberation of carbonic acid that large quantities passed unabsorbed through the baryta water; and, on the operation being terminated, 1.3^{cc} only of the baryta water had not been neutralised. Hence the absorbed portion of the carbonic acid was calculated at 95.3^{mgr}, exclusive of which a very considerable quantity, as before stated, passed off into the atmosphere, the baryta water, placed in a glass tube (resembling in form the letter *U*) connected with the receiver, being surcharged with the gas.

At Professor Waage's suggestion I repeated the experiment with carbonate of lime, precipitated warm and dried at a temperature of 100° C., and succeeded in expelling carbonic acid in considerable, though not so large, quantities as before, whereas an experiment with finely pulverised marble gave no positive result.

The importance of these observations was not to be questioned, affording as they did conclusive proof that the saline mixture in sea-water, on the temperature being raised to the boiling point, decomposed neutral carbonates, and likewise that all carbonic acid determinations hitherto attempted with the object of measuring the carbonic acid present in sea-water were faulty. As regards the carbonic acid determinations performed previous to the publication of Dr. Jacobsen's Memoir on the presence of air in sea-water, such must as a matter of course be wholly worthless, the method of distillation to dryness having in no case been adopted, or that of concentrating the fluid till further evaporation ceased to expel carbonic acid. The

ikke ved fortsat Inddampning skulde kunne have erholdt et større Udbytte af Kulsyre. De af Dr. Jacobsen og J. Y. Buchanan udførte Observationer kunde derimod ikke saa ligefrem forkastes, idet der jo kunde tænkes Mulighed for, at det ved de af dem benyttede Methoder kunde have lykkedes ved den langvarige Kogning at uddrive ogsaa al neutralbunden Kulsyre, i hvilket Fald de af dem opførte Tal i en anden Henseende kunde faa Betydning nemlig som Udtryk for den samlede Sum af den i Søvandet indeholdte Kulsyre.

Desværre lagde flere Omstændigheder Hindringer i Veien for Afslutningen af mine Forsøg over disse Gjenstande i Vinteren 1877—78, dels var min Tid optaget med andre Arbeider, dels lod min Helbred den største Del af Vinteren adskilligt tilbage at ønske, saaat mine Forsøg ingenlunde havde den ønskelige Fremgang, og jeg blev derfor nødt til at gaa ud ogsaa paa Togtet i 1878 uden nogen paalidelig Methode til Bestemmelse af den i Søvandet indeholdte Kulsyre. Da jeg efter endt Togt om Høsten vendte tilbage, gjenoptog jeg imidlertid atter mine Undersøgelser og bragte dem til Afslutning.

Gjennem en netop da af C. Borchers offentliggjort Afhandling[1] om Bestemmelsen af Kulsyren i naturlige Mineralvande blev jeg gjort opmærksom paa det for Bestemmelse af Kulsyren i Carbonater af Alexander Classen angivne Apparat,[2] som jeg senere i stor Udstrækning har benyttet.

Apparatet i den Form, hvori det her er kommen til Anvendelse, findes sammenstillet i Figur 3.

A er 2 med Natronkalk fyldte uformige Rør, *B* indeholder Barytvand. *C* er en Erlenmeyers Kolbe paa circa 0.5 Litre, der gjennem et ved Bunden udmundende Rør communicerer med *B*, medens et lige under Kautschukproppen udmundende sætter den i Forbindelse med Kjøleleren *D*, hvis indre Del efter Classen bestaar af et 27—30^{mm} vidt Glasrør, hvortil i øvre og nedre Ende er loddet Rør med respective 15 og 7^{mm} Diameter. Forlaget *E* er fuldstændig af samme Construction som det af Jacobsen benyttede og er oventil forsynet med det af P. Wagner[3] foreslaaede med Glaskugler fyldte Rør *F*.

Ved *a*, hvor der findes en Indsnevring, er anbragt en noget større Glaskugle, som temmelig nøie dækker over det nederste snevre Rør. Idet det til Opsamling af Kulsyren anvendte titrerede Barytvand heldes ned gjennem *F*, fjernes Proppen *b*, indtil det Meste af Barytvandet har passeret *a*, men sættes derpaa hurtigt i, saaledes at der over de nederste Glaskugler bliver staaende noget Barytvand til en Høide af omtrent 50^{mm} over *a*. Dersom nu

[1] Journ. für pract. Chem. 125 — 353.
[2] Fresenius Zeitschrift 15 — 288.
[3] Fresenius Zeitschrift 9 — 445,

series of observations instituted by Dr. Jacobsen and J. Y. Buchanan cannot however be wholly rejected, since the protracted boiling characteristic of the method they adopted may possibly have driven off all the carbonic acid contained in the carbonates, in which case their figures would acquire importance as expressive of the total amount of carbonic acid present in the sea-water examined.

Unfortunately, divers untoward circumstances conspired to prevent my terminating in the winter of 1877—78 the series of experiments I had begun with the object of elucidating this intricate subject; my time, for instance, came to be unexpectedly occupied in other ways, and during the greater part of that period I suffered from ill-health. My observations, therefore, not having progressed so favourably as I at first had reason to anticipate, I was again obliged to set out on the Expedition, in 1878, without having fixed on any reliable method for determining the carbonic acid present in sea-water. On my return however to Christiania in the autumn of that year, I recommenced the said experiments, and succeeded in bringing them to a satisfactory termination.

A paper by C. Borchers, which had just appeared,[1] on the determination of carbonic acid in mineral water, drew my attention to the apparatus — of which I have since made frequent use — devised by Alex. Classen[2] for determining carbonic acid in carbonates.

Figure 3 represents this apparatus as constructed for my experiments.

A 2 glass tubes, resembling in form the letter *U*, filled with soda-lime; *B* a vessel for baryta water; *C* an Erlenmeyer flat-bottomed matrass, containing about 0.5 litre, which by means of a tube terminating at the bottom is made to communicate with *B*, a similar tube, issuing immediately beneath the caoutschouc stopper, putting it likewise in communication with the cooler *D*, the inner portion of which, according to Classen, should consist of a glass tube from 27^{mm} to 30^{mm} in diameter, with tubes, measuring respectively 15^{mm} and 7^{mm} in diameter, sealed to its upper and lower extremities. The receiver *E* has precisely the same form as that adopted by Jacobsen, and is furnished above with a glass tube, *F*, filled with glass balls, as suggested by P. Wagner.[3]

At the point *a*, where the tube suddenly narrows, is introduced a somewhat larger glass ball, to fill up, as near as may be, the opening of the lower or slender portion of the tube. When the titrated baryta water, which absorbs the carbonic acid, is being poured down through *F*, the stopper *b* has to be taken out, but must be quickly replaced, before the whole of the fluid has passed *a*, in order that the glass balls to a height of about 50^{mm} above *a*

[1] Journ. für pract. Chem. 125, p. 353.
[2] Fresenius Zeitschrift 15, p. 288.
[3] Fresenius Zeitschrift 9, p. 445.

den nederste Glaskugle slutter godt, vil den gjennem *a* passerende Luft spaltes i en Mængde meget fine Blærer, som ved at stige op mellem de af Barytvand omgivne Glaskugler bliver fuldstændig kulsyrefri. Det uformige Rør *G* indeholder Barytvand. *H* fører til Aspiratoren.

may be immersed in baryta water. Now, assuming the large glass ball to fit well, the air will pass *a* in the form of minute bubbles, which, having to ascend between the glass balls surrounded by baryta water, must part with the whole of its carbonic acid. The tube *G* contains baryta water; *H* leads to the aspirator.

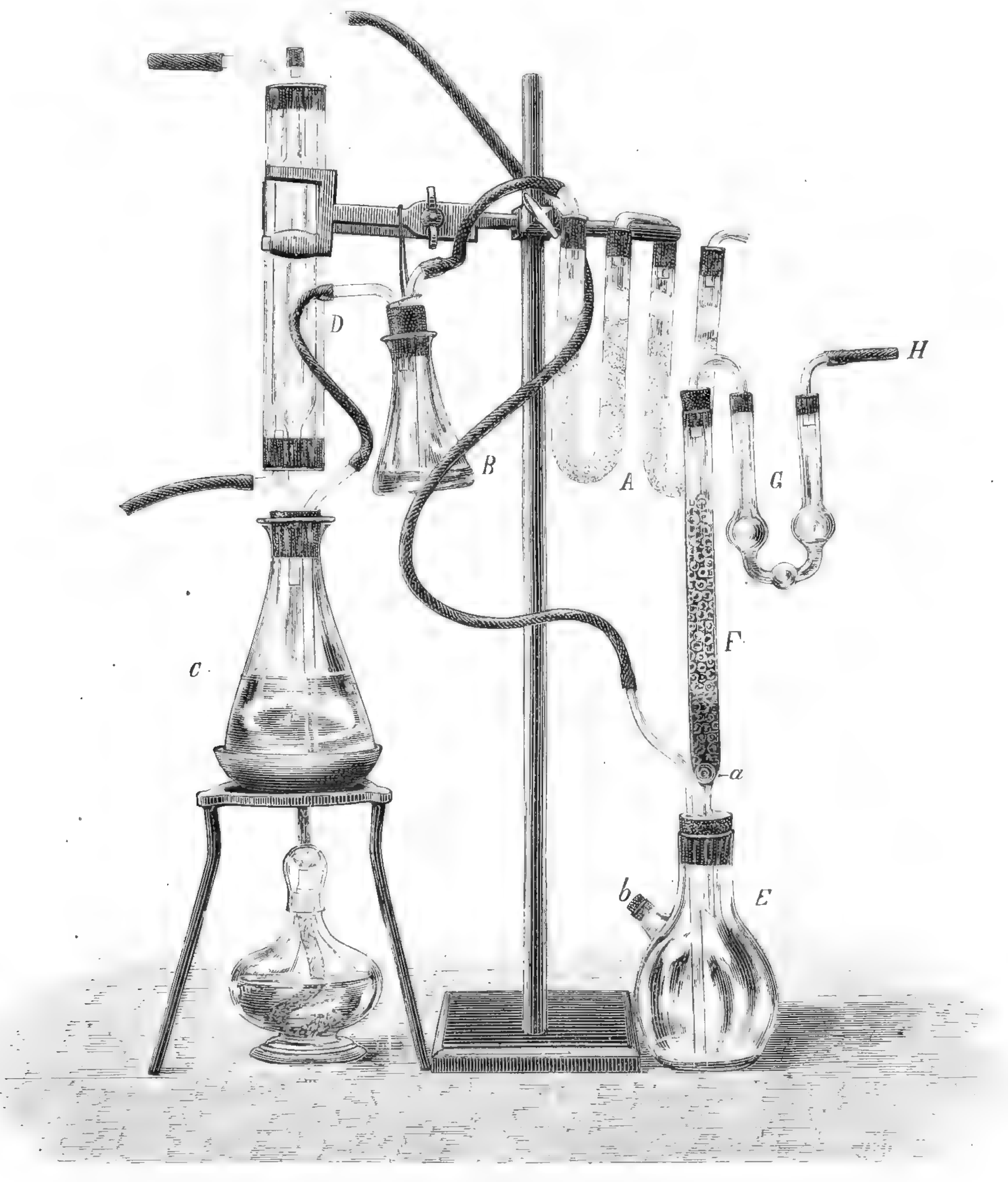


Fig. 3.

Den af Classen foreslaaede Kjøler virker saa udmærket, at man i meget lang Tid kan koge fortyndet Saltsyre i Kolben, uden at det mindste Spor af Chlor kan paavises i Forlaget, forudsat at den gjennemledede Luftstrøm ikke gives for stor Hastighed, hvad der imidlertid heller ikke er fornødent.

The cooler devised by Classen is so excellent, that diluted hydrochloric acid may be boiled in the matrass for a very considerable length of time without a trace of acid being detected in the receiver, provided that too great rapidity be not given to the current of air; this, however, is quite unnecessary.

Naar Søvandet i dette Apparat kogtes med fortyndet Svovlsyre i en kulsyrefri Luftstrøm, undveg Kulsyren meget hurtigt, idet 15 Minutters Kogning fuldstændig strak til for at bringe al Kulsyre over i Forlaget. Søvandets Sulfater viste altsaa i alle Fald ikke ved Tilstedeværelsen af fri Syre de af J. Y. Buchanan observerede Egenskaber. Naar den paa denne Maade uddrevne Kulsyremængde opsamledes og bestemtes, viste den sig altid at stemme nogenlunde med, hvad man efter den af Dr. Jacobsen anvendte Methode kunde erholde uddrevet, idet de optrædende Afvigelser snart vare positive snart negative men i Regelen ikke større, end at de for den største Del maatte kunne tilskrives Observationsfeil. Ved den af Buchanan i Forslag bragte Udfældning af Svovlsyren erholdt jeg derimod bestandig betydelig for lave Resultater, hvorom senere.

For samtidig i en og samme Portion at kunne bestemme baade den neutralbundne og den samlede Mængde Kulsyre, anvendte jeg følgende Fremgangsmaade.

Efterat Apparatet fuldstændig var befriet for kulsyreholdig Luft, anbragtes i Forlaget paa den for beskrevne Maade 25 CC. Barytvand, hvoraf hver CC. svarede til 4,129 Mgr. Kulsyre, hvorefter der i Kolben C heldtes 367.7 CC. af det til Undersøgelse bestemte Søvand tilligemed 10 CC. af en Svovlsyre, hvoraf hver CC. svarede til 4.099 Mgr. Kulsyre. Indholdet i Kolben ophededes nu under Gjennemledning af en meget langsom Luftstrøm til Koghede og holdtes i Kog i nogen Tid. Efter Forløb af henimod 15 Minutter fjernedes atter Varmekilden og Vædsken afkjøledes, idet Luftstrømmen lidt efter lidt gaves en noget større Hastighed, hvorved den endnu ikke absorberede Kulsyre meget hurtigt bragtes over i Forlaget.

Efter endt Operation bragtes de i F værende Glaskugler tilligemed det ved Rørets Vægge heftende Barytvand ned i Forlaget E, hvorpaa det Hele retitreredes med en Oxalsyre, hvoraf hver CC. svarede til 3.976 Mgr. Kulsyre, idet alkoholisk Curcuma tjente som Index. Ligeledes skylledes den ved de indre Vægge af Kjøleren heftende Vædske ved lidt kulsyrefrit destilleret Vand ned i Kolben, hvori den overskydende Syre neutraliseredes med en Natronlud, hvoraf hver CC. svarede til 2.928 Mgr. CO_2, idet Rosolsyre tjente som Index.

Som Resultat af disse Titreringer erholdtes den samlede Kulsyremængde bestemt til omkring 97 Mgr. og den neutralbundne til gjennemsnitlig henimod 53 Mgr. pr. Litre. De 44 Mgr. Kulsyre, som udgjør Differentsen mellem den samlede Kulsyremængde og den neutralbundne, kan aabenbart ikke forekomme i Søvandet som fri Gasart, men maa forene sig med de allerede færdigdannede Carbonater under Dannelsen af Bicarbonater, og det viser sig altsaa, at de af Dr. Jacobsen gjorte Observationer meget naturligt lade sig forklare derved, at Søvandet ikke indeholder det mindste Spor af fri Kulsyre men hele 53 Mgr. neutralbunden og kun omkring 44 Mgr. surtbunden Kulsyre pr. Litre.

On boiling sea-water along with diluted sulphuric acid, exposed to a current of air free from carbonic acid, in this apparatus, carbonic acid escaped very rapidly, the space of 15 minutes sufficing to collect the whole of it in the receiver. The sulphates in sea-water — at least when free acids were present — did not, accordingly, exhibit the properties ascribed to them by J. Y. Buchanan. On collecting and determining the carbonic acid driven off by this process, the amount was invariably found to agree with that which could be liberated by Dr. Jacobsen's method, the differences observed having been sometimes positive and sometimes negative, but as a rule not greater than would admit of imputing them chiefly to errors of observation. On precipitating the sulphuric acid as suggested by Buchanan, the results obtained were invariably too low; but to this subject I shall afterwards return.

In order to determine both the proportion of carbonic acid forming the neutral carbonates and the whole amount of carbonic acid contained in one and the same sample of sea-water, I adopted the following mode of procedure.

After expelling from the apparatus all air in which carbonic acid was present, 25^{cc} of baryta water were introduced, as previously described, into the receiver, each c.centim. representing 4.129^{mgr} carbonic acid; 367.7^{cc} of the sea-water to be examined were then poured into the matrass (C), along with 10^{cc} of sulphuric acid, each c.centim. of which represented 4.099^{mgr} carbonic acid. The contents of the matrass were now heated, during exposure to a very slow current of air, up to the boiling-point, and kept for some time at that temperature. After the lapse of about 15 minutes, the source of heat was removed and the fluid cooled, the rapidity of the current of air being slightly increased, causing the carbonic acid not yet absorbed to pass off quickly into the receiver.

The operation being terminated, the glass balls in the tube F, along with the baryta water adhering to the walls of the tube, were introduced into the receiver E, and the whole of its contents retitrated with oxalic acid, each c.centim. of which represented 3.976^{mgr} carbonic acid, a solution of alcoholic curcuma serving as the index. The fluid adhering to the walls of the cooler was likewise washed down into the matrass with a little distilled water free from carbonic acid, and the surplus acid neutralised by the addition of soda-lye, each c.centim. of which represented 2.928^{mgr} CO_2, rosolic acid serving as the index.

As the result of this titration, the total amount of carbonic acid was found to be about 97^{mgr} and the proportion forming neutral carbonates to average about 53^{mgr} per litre. Now, the difference, 44^{mgr}, cannot occur free as gas, but will unite with the carbonates to form bicarbonates; and hence Dr. Jacobsen's observations could be readily explained on the assumption that sea-water contains no trace even of free carbonic acid, but as much as 53^{mgr} per litre of carbonic acid forming carbonates and only about 44^{mgr} per litre of carbonic acid forming bicarbonates.

Som man ser, er den her til Bestemmelse af den neutralbundne Kulsyre anvendte Methode i alt væsentligt den samme, som allerede for flere Aar tilbage er beskreven af Dr. Mohr.[1] Forskjellen stikker kun deri, at jeg har anvendt Classens Kjøler og desuden ombyttet Salpetersyren med Svovlsyre. Det syntes mig nemlig ikke tilraadeligt at anvende Salpetersyre ligeoverfor et saa stærkt chlorholdigt Mineralvand som Søvand, hvori der desuden fandtes en vel mærkbar om end temmelig liden Qvantitet oxyderbare Stoffe.

Efter denne Fremgangsmaade har jeg senere ved 78 Observationer bestemt Kulsyren i 64 forskjellige Vandprøver temmelig jevnt fordelte over det af den norske Nordhavexpedition undersøgte Felt. Resultaterne findes sammenstillede i Tabel II.

Først skal i Korthed berøres de Feil, hvormed de i Tabellen opførte Tal kan tænkes beheftede.

Om man vilde antage, at den i Søvandet indeholdte Kiselsyre ikke forekom opløst som fri Syre, men forefandtes bundet til Baser i Form af Silicater, en Antagelse af meget tvivlsom Berettigelse, vilde man aabenbart efter den ovenfor beskrevne Methode faa noget feilagtige Resultater, idet den til Kiselsyre bundne Mængde Baser vilde findes som bunden til Kulsyren. Forat kunne danne mig en Forestilling om, hvorvidt den Feil, som man under denne Forudsætning skulde kunne begaa, nogensinde vil kunne tænkes at faa særlig Betydning, har jeg bestemt Kiselsyremængden i forskjellige af de hjembragte Vandprøver, idet følgende Fremgangsmaade er kommen til Anvendelse. 0.5 Litre Søvand inddampedes med lidt Saltsyre i en Platinaskaal først over fri Ild senere paa Vandbad til Tørhed og tørredes ved 110°—120° C. Saltene udtoges derpaa og pulveriseredes bedst muligt i en vel poleret Agatriveskaal, hvorpaa de atter tørredes ved samme Temperatur, og sluttelig bragtes over i et passende Kar og tilsattes ca. 200 CC. saltsyreholdigt Vand, hvorved al Gips fuldstændigt opløstes. De paa denne Maade udskilte Kiselsyremængder vare altid meget smaa og maatte nærmest blive at betegne som Spor, idet de, hvor jeg forsøgte at veie dem, kun beløb sig til Brøkdele af Mgr. i den anvendte Portion Vand. Dette stemmer paa det Nøieste med, hvad Thorpe og Morton nylig har fundet i det irske Hav,[2] hvorimod de ældre Opgaver giver noget større Tal. Og man vil saaledes se, at der ingensomhelst Rimelighed er for, at den i Søvandet indeholdte Kiselsyremængde skulde bidrage til i mærkelig Grad at gjøre de fundne Resultater upaalidelige.

Naar man skal danne sig en Mening om Nøiagtigheden af disse Observationer, er det imidlertid nødvendigt at tage Hensyn til en anden Omstændighed, som kunde tænkes at have havt sin Indflydelse paa Resultaterne.

[1] Mohr Titrirmethode 3te Aufl. — 524.

[2] Ann. Chem. Pharm. 158 — 122.

As will be seen, the method adopted for the determination of the carbonic acid forming carbonates, was essentially the same as that described by Dr. Mohr[1] several years previously. The only difference lay in my having employed Classen's cooler and made choice of sulphuric acid in preference to nitric. It did not seem advisable to use nitric acid when examining a mineral water so rich in chlorine as is sea-water, and which besides contains a quantity, small indeed but appreciable, of organic matter.

By this process I subsequently determined the carbonic acid in 64 different samples of sea-water, drawn at comparatively regular intervals from the tract of ocean investigated on the Norwegian North-Atlantic Expedition: the number of observations amounted to 78. The results are given in Table II.

I will first say a few words respecting the errors that may possibly affect the accuracy of the figures set down in the Table.

Assuming the silicic acid in sea-water not to occur as a free acid, but combined with bases in the form of silicates, an hypothesis of very doubtful value, the results obtained by the method described above would be obviously to some extent inaccurate, inasmuch as the bases combined with silicic acid must in that case have behaved as if originally combined with carbonic acid. In order to ascertain what importance could possibly be attached to an error arising on such an assumption, I determined the amount of silicic acid in divers of the samples of sea-water brought home with me, adopting for that purpose the following method. Five-tenths of a litre of sea-water mixed with a little hydrochloric acid were evaporated to dryness in a platinum dish, at first over a common fire and then in a water-bath, and dried at a temperature of 110°—120° C. The salts were then taken out and transferred to a well polished agate dish, in which they were finely pulverised, and again dried at the same temperature; finally they were placed in a suitable vessel, and mixed with about 200^{cc} of water containing hydrochloric acid, which thoroughly dissolved all the gypsum. The amounts of silicic acid thus precipitated were invariably very small, indeed but little more than traces; for, on attempting to weigh them, they proved to be but fractions of a milligramme. This result agrees exactly with the observations of Thorpe and Morton on water from the Irish Sea,[2] whereas the figures in earlier statements are somewhat higher. Hence, there is no reason whatever to assume, that the silicic acid present in sea-water should to any considerable extent influence the results obtained.

When judging of the accuracy of these observations, regard must, however, be had to another circumstance that might possibly in some measure affect the results. The water examined did not consist of freshly drawn samples,

[1] Mohr's Titrirmethoden 3te Aufl. p. 524.

[2] Ann. Chem. Pharm. 158, p. 122.

Tabel II.

No.	Stat. No.	Nordlig Bredde. (North Latitude.)	Længde fra Greenwich. (Longitude from Greenwich.)	Dybde hvorfra Prøven hentet. (Depth from which the Samples were collected.) Engelske Favne. (English Fathoms.)	Meter. (Metres.)	Temperatur. Celsius.	Neutralbunden Kulsyre. (Carbonic Acid forming Carbonates.) Mgr. per Litre.	Surtbunden Kulsyre. (Carbon. Acid forming Bicarbonates.) Mgr. per Litre.	Anmærkninger. (Remarks.)
1	—	Jæderen.		0	0	?	52.3	41.1	
2	51	65° 53′	7° 18′ W.	1163	2127	—1.1	52.6	46.7	
3	52	65 47.5	3 7	1861	3403	—1.2	52.7	46.9	
4	52	65 47.5	3 7	1861	3403	—1.2	52.9	46.1	
5	53	65 13.5	0 33 E.	1539	2814	—1.3	53.1	43.8	
6	53	65 13.5	0 33	0	0	10.5	54.3	40.4	
7	143	66 58	10 33	189	346	6.2	53.8	43.3	
8	143	66 58	10 33	0	0	8.2	53.4	41.5	
9	183	69 59.5	6 15	1600	2926	—1.2	52.6	44.8	
10	183	69 59.5	6 15	0	0	8.6	53.5	44.8	
11	184	70 4	9 50	1547	2829	—1.3	53.0	45.5	
12	184	70 4	9 50	600	1097	0.0	52.4	44.7	
13	184	70 4	9 50	0	0	7.6	53.8	40.9	
14	187	69 51.5	14 41	1335	2441	—1.1	53.8	43.1	
15	189	69 41	15 42	860	1573	—1.1	53.0	45.5	
16	189	69 41	15 42	860	1573	—1.1	52.7	43.6	
17	189	69 41	15 42	0	0	9.6	54.2	41.8	
18	215	70 53	2 0 W.	0	0	8.0	54.2	41.4	
19	215	70 53	2 0	200	366	2.8	52.6	—	
20	215	70 53	2 0	200	366	2.8	52.6	46.8	
21	217	71 0	5 8	0	0	4.6	52.7	41.3	
22	226	70 59	7 51	340	622	—0.6	54.3	46.4	
23	226	70 59	7 51	340	622	—0.6	54.6	46.0	
24	226	70 59	7 51	340	622	—0.6	54.7	—	
25	226	70 59	7 51	0	0	3.0	52.2	40.7	
26	226	70 59	7 51	0	0	3.0	52.2	41.6	
27	237	70 41	10 10	0	0	3.0	53.4	42.4	
28	237	70 41	10 10	0	0	3.0	54.5	39.7	
29	240	69 2	11 26	0	0	4.2	55.0	44.4	
30	240	69 2	11 26	0	0	4.2	55.4	—	
31	—	68 33	7 25	0	0	6.0	53.0	45.0	
32	—	68 33	7 25	0	0	6.0	53.0	43.9	
33	243	68 32.5	6 26	1385	2533	—1.3	53.7	42.4	
34	245	68 21	2 5	0	0	9.0	53.8	45.2	
35	245	68 21	2 5	0	0	9.0	53.8	44.2	
36	247	68 5.5	2 24 E.	500	914	—0.4	53.9	47.3	
37	247	68 5.5	2 24	0	0	9.4	54.0	47.2	
38	264	70 56	35 37	0	0	5.2	51.8	42.3	
39	264	70 56	35 37	86	157	1.9	52.6	43.2	
40	275	74 8	31 12	0	0	2.9	53.0	45.3	
41	284	73 1	12 58	0	0	6.8	52.6	43.2	
42	295	71 59	11 40	0	0	7.0	52.8	42.4	
43	295	71 55	11 30	100	183	3.2	51.9	42.8	
44	295	71 55	11 30	600	1097	—0.8	52.6	43.7	
45	295	71 59	11 40	1110	2030	—1.3	53.8	43.1	
46	297	72 36.5	5 12	0	0	4.6	52.6	43.7	
47	297	72 36.5	5 12	1280	2341	—1.4	52.1	43.4	
48	298	72 52	1 50.5	1500	2743	—1.5	52.2	42.9	
49	300	73 10	3 22 W.	0	0	1.7	48.6	43.4	Øst lige ved Kanten af Grønlandsisen. (Drawn in immediate proximity to the Greenland Ice.)
50	300	73 10	3 22	0	0	1.7	48.4	42.0	
51	303	75 12	3 2 E.	0	0	3.3	52.2	47.9	
52	303	75 12	3 2	0	0	3.3	51.8	48.0	
53	303	75 12	3 2	150	274	—1.1	51.8	43.0	
54	304	75 3	4 51	300	549	—0.8	52.2	42.5	
55	304	75 3	4 51	300	549	—0.8	52.3	45.1	
56	304	75 3	4 51	1735	3173	—1.5	52.4	43.9	
57	306	75 0	10 27	1334	2440	—1.3	52.0	40.5	
58	323	72 53.5	21 51	223	408	1.5	53.1	42.1	

No.	Stat. No.	Nordlig Bredde. (*North Latitude.*)	Længde fra Greenwich. (*Longitude from Greenwich.*)	Dybde hvorfra Proven hentet. (*Depth from which the Samples were collected.*) Engelske Favne. (*English Fathoms.*)	Meter. (*Metres.*)	Temperatur. Celsius.	Neutralbunden Kulsyre. (*Carbonic Acid forming Carbonates.*) Mgr. per Litre.	Surtbunden Kulsyre. (*Carbon. Acid forming Bicarbonates.*) Mgr. per Litre.	Anmærkninger. (*Remarks.*)
59	335	76° 16'.5	14° 39' E.	0	0	5.4	53.4	42.7	
60	347	76 40.5	7 47	1429	2613	—1.3	52.2	41.6	
61	347	76 40.5	7 47	0	0	4.4	52.6	41.0	
62	349	76 30	2 57	1487	2719	—1.5	51.6	43.5	
63	350	76 26	0 29 W.	0	0.	3.0	54.0	47.2	
64	350	76 26	0 29	300	549	—1.1	53.2	45.8	
65	350	76 26	0 29	300	549	—1.1	53.3	46.0	
66	350	76 26	0 29	1686	3083	—1.5	51.9	43.9	
67	351	77 49.5	0 9	0	0	3.3	51.9	42.8	
68	352	77 56	3 29 E.	0	0	3.9	52.3	41.5	
69	352	77 56	3 29	300	549	—0.8	52.6	46.0	
70	355	78 0	8 32	0	0	4.9	52.4	43.2	
71	355	78 0	8 32	948	1734	—1.3	51.8	44.6	
72	361	79 8.5	5 28	0	0	4.2	52.4	42.7	
73	361	79 8.5	5 28	905	1655	—1.2	51.9	46.1	
74	362	79 59	5 40	0	0	5.2	52.6	43.2	
75	362	79 59	5 40	459	839	—1.0	51.8	44.6	
76	363	80 0	8 15	260	475	1.1	52.9	44.0	
77	368	78 43	8 20	315	567	1.6	52.9	42.4	
78	373	78 10	14 26	120	219	0.8	51.4	44.4	

Forsogene ere nemlig ikke blevne udførte paa Vandproverne strax efter deres Optagelse men først, efterat de have henstaaet i kortere eller længere Tid. Angaaende Tidsrummet, hvori de enkelte Vandprøver have henstaaet før Bestemmelsen, kan anføres Følgende: No. 1, en Vandprøve, som Hr. Dampskibsfører E. Rostrup viste mig den Velvillie at skaffe mig, har kun henstaaet nogle Dage, de øvrige Prøver have henstaaet, No. 2—6 i ca. 2¼ Aar, 7—37 i ca. 1¼ Aar og 38—78 i 2 til 4 Maaneder paa et kjøligt Sted opbevarede paa Flasker, der vare forsynede med vel islebne Glasproppe. Der aabner sig altsaa en Mulighed for, at der ved Oxydation af de i Søvandet værende, aldrig manglende, organiske Bestanddele kunde have dannet sig en mindre Qvantitet Kulsyre paa Bekostning af den opløste Surstofmængde, en Proces, der naturligvis kun har Indflydelse paa den surt bundne Kulsyre, saafremt ikke Oxydationen skulde skride saa vidt frem, at ogsaa Surstoffet i Svovlsyren skulde medgaa til Dannelsen af Kulsyre, i hvilket Fald den dannede Kulsyre maatte træde ind som neutralbunden istedetfor den destruerede Mængde Svovlsyre. En saa vidt fremskreden Oxydation kan imidlertid ikke tænkes mulig, medmindre man til Prop i Flaskerne anvender Kork, da den i Søvandet opløste Surstofgas er mere end tilstrækkelig til at oxydere alle de oprindelig tilstedeværende organiske Bestanddele. Det kan ogsaa bemærkes, at det ikke i nogen af de undersøgte Vandprøver har været muligt at paavise det mindste Spor af Svovlvandstof. For saa nogenlunde at fixere de Mængder Kulsyre, som paa denne Maade skulde kunne dannes, har jeg anmodet min Ven Schmelck, som har været beskjæftiget med Undersøgelse af de faste Bestanddele i Vandet i det af Expeditionen befarede Hav, og som saaledes ogsaa har

having all of it been allowed to stand over for a longer or shorter period. With respect to the interval that had elapsed before commencing the determinations, the following particulars can be given: — No. 1, a sample of sea-water which Captain E. Rostrup had the kindness to procure me, did not stand over for more than a few days; of the remaining samples, Nos. 2—6 were preserved for about two years and a quarter, Nos. 7—37 for about one year and a quarter, and Nos. 38—78 from two to four months, all of them in a cool spot, and in bottles furnished with ground glass stoppers. Hence it is just possible that oxidation of the organic matter never absent in sea-water may have produced a small quantity of carbonic acid, by reducing the amount of oxygen, a process which of course could only affect the carbonic acid forming bi-carbonates, unless indeed oxidation were so far advanced, that the oxygen in the sulphuric acid should also contribute to the formation of carbonic acid, in which case such carbonic acid would reimplace the sulphuric acid decomposed. But this advanced stage of oxidation is clearly impossible unless the bottles are *corked*, since the oxygen in sea-water is more than sufficient to oxidize all organic matter originally present. I can also observe, that in none of the samples of water examined was it possible to detect the slightest trace of sulphuretted hydrogen. With the object of determining approximately what proportion of carbonic acid could result from this process, I requested my friend Mr. Schmelck — whose labours have been chiefly confined to the examination of the solid matter present in the water of the seas explored on the Expedition, and who accordingly instituted a series of experiments to ascertain the amount of organic substances it contained — to furnish

udført en Række Forsøg til Bestemmelse af de organiske Stoffes Mængde, om at meddele mig de fornødne Data. Ifølge ham ere de organiske Stoffes Mængde kun underkastet meget smaa Variationer, og affarver 1 Litre Søvand gjennemsnitlig 3 Mgr. Kamæleon, som under Forudsætning af Reduction til Oxydulsalt kun kan afgive henimod 0.8 Mgr. Surstof, hvoraf det lettelig vil kunne indsees, at den dannede Mængde Kulsyre ikke kan være meget stor, naar Surstofforbruget selv ved en saa energisk Oxydation som ved Anvendelse af Kamæleon er saa lidet. Og hvad der især tyder paa, at den Oxydation, som kan foregaa ved Vandprøvens Henstand under ordinære Forholde, fuldstændig maa kunne negligeres, er den Omstændighed, at Schmelck har fundet Søvandets Evne til at affarve Kamæleon ligestor, hvadenten Vandprøven undersøges frisk eller først efter aarelang Henstand.

At noget af Kulsyren ved den lange Henstand skulde være fordampet, er der heller ingen Rimelighed for, naar man erindrer, at Søvandet er en alkalisk Vædske, som ikke indeholder det mindste Spor af fri Kulsyre, og som med saadan Kraft holder paa sin surt bundne Kulsyre, at den i timevis kan koges i det af Jacobsen angivne Luftudkogningsapparat med det Resultat, at kun en meget liden Brøkdel uddrives. Der er aabenbart større Fare for det Modsatte, nemlig at der skulde kunne absorberes noget af Atmosphærens Kulsyre, men for Undgaaelsen af denne Feilkilde er der sørget ved omhyggelig Opbevaring paa velproppede Flasker.

Resultaterne synes heller ikke at tyde paa, at Henstanden skulde have været til Skade for Vandprøvernes Brugbarhed, idet de alle uden Hensyn til den meget forskjellige Varighed af det Tidsrum, hvori de have henstaaet, vise nogenlunde det samme Resultat, og jeg tror saaledes ikke at tage meget Feil, naar jeg anser de af mig udførte Observationer som i alt Væsentligt ligesaa gode, som om de havde været udførte ombord paa friskt optagne Vandprøver.

Hvad angaar de af selve Methoden og Experimentationen flydende Observationsfeil, da vil de hyppigt udførte Controlbestemmelser kunne give de fornødne Bidrag til Bedømmelsen af deres Størrelse, saaledes er ved 13 Controlbestemmelser for den neutralt bundne Kulsyres Vedkommende den gjennemsnitlige halve Differents mellem 2 paa samme Vandprøve udførte Observationer bestemt til 0.11 Mgr. per Litre (Maximum 0.6) og for den surt bundne Kulsyres Vedkommende til 0.59 Mgr. per Litre (Maximum 1.35). Foruden den variable Feil vil der imidlertid i sidste Tilfælde ogsaa være en constant, idet det ikke lader sig undgaa, at man ved Arbeide i en kulsyreholdig Atmosphære vil erholde noget om end meget lidet for høie Resultater. Naar Feilene ved Bestemmelsen af den surt bundne Kulsyre er funden at være størst, da er Grunden dertil for en stor Del at søge deri, at man ved Retitration med Natronlud, især naar Rosolsyre anvendes som Index, erholder en meget skarp Endereaction, medens dette paa lang Vei ikke i samme Grad er Tilfælde, hvor Baryt re-

me with the necessary data. According to his observations, the amount of organic matter varies but very slightly, 1 litre of sea-water discolouring on an average 3^{mgr} permanganate of potash; and this quantity, assuming extreme reduction, cannot give off more than about 0.8^{mgr} of oxygen. Hence it is obvious that the amount of carbonic acid cannot be very large, considering the limited consumption of oxygen even with the use of permanganate of potash. But that the oxidation which can ordinarily result from allowing the water to stand over may be altogether ignored, is more particularly indicated by the fact of Schmelck having found the property in sea-water of discolouring permanganate of potash to be invariably the same, whether the samples are freshly drawn or have been preserved for years together.

Nor is there reason to assume, that any portion of the carbonic acid should have escaped by evaporation during the long interval, if we bear in mind that sea-water is an alkaline fluid, which does not contain the smallest trace of free carbonic acid, and which retains that present in bicarbonates with such vigour, that it may be boiled for hours together in the apparatus devised by Jacobsen for boiling out air and not part with more than a mere fraction. Nay, there is obviously danger of the reverse, viz. that some of the carbonic acid present in the atmosphere will be absorbed; but that source of error was effectually avoided by keeping the water in bottles provided with tight-fitting glass stoppers.

Judging, too, from the results, which were very nearly the same for all the samples, irrespective of the difference in the length of the period during which they had been preserved, the interval that had elapsed previous to examination did not appear to have had any injurious effect on the water for experimental purposes; and hence I feel tolerably convinced that my observations in all essential particulars are as reliable as if they had been conducted on board with freshly drawn water.

With respect to the errors of observation involved in the method itself, numerous test-determinations will serve as an approximate standard by which to compute their magnitude; thus, for instance, half the difference between two observations with the same sample of water was found, for the carbonic acid forming carbonates, to be 0.11^{mgr} per litre (maximum 0.6), and for the carbonic acid forming bicarbonates to be 0.59^{mgr} per litre (maximum 1.35). Exclusive of the variable error there will also, in the latter case, be a constant one, inasmuch as the results of experiments performed in an atmosphere containing carbonic acid must necessarily be somewhat, if but a very little, too high. When the error in the determination of the carbonic acid forming bicarbonates is found to be greatest, the reason will be chiefly this, that retitration with soda-lye, more especially if rosolic acid has been selected as the index, gives rise to a very decided terminal reaction, which does not result on the baryta water being titrated with oxalic acid; the reaction is then much less obvious. It must be likewise

titreres med Oxalsyre. Tillige bør det erindres, at de som Udtryk for den surt bundne Kulsyre opførte Tal indeholde Feilene saavel i Bestemmelsen af den neutralt bundne som den samlede Kulsyremængde.

Som man let vil overbevise sig om, vise de i Tabellen opførte Tal især for den neutralt bundne Kulsyres Vedkommende en mærkelig Overensstemmelse, naar nemlig 2 Observationer, begge udførte paa en Vandprøve hentet lige ved Grønlandsisen, undtages, ligger i alle de øvrige 63 Vandprøver den neutralt bundne Kulsyre mellem Grændserne 51.4 og 55.4 Mgr. per Litre, saaledes at den største Differents kun beløber sig til 4 Mgr., hvad der maa siges at være meget lidet i Betragtning af, at disse Tal ere fremkomne ved Undersøgelse af et Hav paa betydeligt over 200 geografiske Mile i Udstrækning saavel i syd og nord som øst og vest. Hvad derimod den surt bundne Kulsyre angaar, da ere de optrædende Differentser betydelig større og beløbe sig i Ydertilfældene til omkring 8 Mgr. pr. Litre.

Jeg har længe bestræbt mig for at opdage nogen Lovmæssighed i disse Variationer, uden at det dog saaledes som for Luftens Vedkommende har lykkes at erholde klare og paalidelige Resultater i saa Henseende og det ligegyldigt, hvadenten man vælger Dybdeforholdene eller den geografiske Beliggenhed til Udgangspunkt for sin Betragtning.

Da saaledes ingen Del af det undersøgte Felt udmærker sig fremfor den anden ved nogen tydelig Forskjellighed i Kulsyregehalt, og da de optrædende Differentser overalt ere smaa, ville de erholdte Resultater naturligst være at benytte til Udledning af Gjennemsnitsværdier, der kunne opføres som Udtryk for Kulsyregehalten i det undersøgte Hav i sin Helhed betragtet. De Gjennemsnitsværdier, som saaledes blive at opstille som Hovedresultater, ere for den neutralt bundne Kulsyres Vedkommende

$$52.78 \pm 0.083 \text{ Mgr. pr. Litre}$$

med en sandsynlig Afvigelse herfra af en enkelt Observation af $\pm$ 0.662 Mgr. pr. Litre

og for den surt bundne Kulsyres Vedkommende

$$43.64 \pm 0.16 \text{ Mgr. pr. Litre}$$

med en sandsynlig Afvigelse herfra af en enkelt Observation af $\pm$ 1.26 Mgr. pr. Litre.

Da det først var bragt paa det Rene, at de af Dr. Jacobsen iagttagne Egenskaber hos Søvandet skrev sig derfra, at den i Søvandet existerende Saltblanding ved Koghede decomponerede neutrale Carbonater, maatte det ogsaa fremstille sig som en meget interessant Opgave at finde den nærmere Forklaring dertil.

Den nærmestliggende Tanke, som i denne Anledning først paatvang sig mig, var den at søge Grunden i Chlormagnesiumens bekjendte Egenskaber. At denne under Kogningen selv ved Tilstedeværelsen af Overskud af Chlornatrium skulde have Tilbøielighed til lidt efter lidt at spalte sig, og at der af den dannede Saltsyre skulde kunne uddrives noget Kulsyre, kunde jo ikke synes umuligt. Der

borne in mind, that the figures representing the carbonic acid forming bicarbonates also include the error in both titrations.

A glance at the Table will show that the figures therein set down, more particularly those representing the carbonic acid forming carbonates, exhibit a remarkable uniformity; save in 2 observations, both with a sample of water drawn in close proximity to the ice off the coast of Greenland, the carbonic acid forming carbonates determined in the remaining 63 samples lies between the limits 51.4^{mgr} and 55.4^{mgr} per litre and the greatest difference amounts therefore to only 4^{mgr}, which must be regarded as very small, considering that the said figures refer to the examination of water from a tract of ocean which, measured both from north to south and from east to west, extends for considerably more than 200 geographical miles. As regards the carbonic acid forming bicarbonates, the differences in the amounts determined are, however, much greater, reaching 8^{mgr} per litre.

I have long had my attention directed to the possible discovery of a law controlling these variations, similar to that which I found to regulate those of air, but have not yet succeeded in obtaining conclusive results; and it is quite immaterial whether depth or geographical position be made the basis of investigation.

The water in no part of the ocean-tract explored being characterised by properties plainly distinguishing it from that of any other, and the differences in the results obtained having invariably proved small, the latter will obviously serve for the computation of average formulæ representing the amount of carbonic acid present in the water of the sea investigated. These average formulæ, set down accordingly as the final results, were found to be —

$$52.78 \pm 0.083^{mgr} \text{ per litre}$$

for the carbonic acid forming carbonates, with a probable error in a single observation of $\pm$ 0.662 per litre; and

$$43.64 \pm 0.16^{mgr} \text{ per litre}$$

for the carbonic acid forming bicarbonates, with a probable error in a single observation of $\pm$ 1.26^{mgr} per litre.

Having now obtained conclusive proof that the properties observed by Dr. Jacobsen in sea-water were the result of the property possessed by the saline compounds present therein of decomposing at the boiling-point neutral carbonates, the next step was to find a satisfactory explanation of the interesting phenomenon.

My first thought in this direction was to seek the cause in the known properties of chloride of magnesia. Assuming this body to have a tendency of gradually decomposing during the process of boiling, carbonic acid might possibly be driven off by the hydrochloric acid formed. Against such an hypothesis, however, various objections may be raised, Dr. Jacobsen and others having shown that sea-

lader sig imidlertid reise Indvendinger mod denne Betragtningsmaade, idet det af Dr. Jacobsen med Flere er paavist, at Søvand lader sig inddampe til Tørhed og Saltene endog tørre ved en Temperatur af 180° C., uden at nogen synderlig Mængde Saltsyre fortflygtiger sig, og det er i Virkeligheden heller ikke fornødent at ty til Chlormagnesiumens Dissociation for at finde den rimeligste Forklaringsgrund. Man behøver blot at holde sig til den kulsure Magnesia og dens Egenskaber, saaledes som de ere kjendte af Arbeider udførte af de mest berømte Chemikere.

Ifølge Angivelser af Berzelius,[1] H. Rose,[2] Fritzsche,[3] Nörgaard[4] og L. Joulin[5] er den ved høiere Temperatur dannede kulsure Magnesia altid mere eller mindre basisk, ja ifølge Berzelius og H. Rose er selv de ved Blanding af Magnesiaoplosninger med kulsure Alkalier i Kulden dannede Bundfald mere kulsyrefattige end mættet kulsur Magnesia. Der findes om den kulsure Magnesia et meget stort Antal tildels meget modstridende Angivelser, og der er, eftersom Fremstillingsmaaden er varieret, erholdt meget forskjelligt sammensatte Salte, hvis procentiske Sammensætning ifølge Analyserne stemme meget daarligt overensmed den af de opstillede Formler beregnede. Disse Forbindelser ere ogsaa af enkelte Forfattere betragtede som basiske Salte af variabel Sammensætning og ansees af L. Joulin endog for en Blanding af vexlende Mængder Oxyd og Carbonat. Det vilde føre for langt her at gjennemgaa de talrige over dette Emne forfattede Afhandlinger, og jeg skal derfor indskrænke mig til at henvise til Gmelin-Kraut's Handbuch der Chemie 6te Aufl. 2 432, hvor det Væsentligste findes i Uddrag. Det maa dog være mig tilladt at citere nogle Udtalelser af H. Rose, som jeg nylig blev opmærksom paa, Udtalelser, som vise at Videnskaben allerede meget længe har været i Besiddelse af Materiale til Forklaringen af de af Dr. Jacobsen gjorte Observationer. H. Rose siger (Pogg. Ann. [3] — 23 — 417) Følgende:

"Als das Gesetz der einfachen chemischen Proportionen aufgestellt und hinreichend durch Versuche bewiesen worden war, ergab sich die Neutralität zweier sich zersetzender Salzauflösungen als eine ganz natürliche Folge des Gesetzes der bestimmten Verhältnisse, in denen sich alle Körper, also auch Säuren und Basen, mit einander verbinden.

Aber das Gesetz, dass durch Zersetzung zweier neutraler Salze nach ihrer Auflösung in Wasser wiederum zwei neutrale Salze entstehen, ist nicht richtig, wenigstens nicht in der Allgemeinheit, wie es bisher ohne den geringsten Widerspruch angenommen worden ist.

Es ist bemerkenswerth, dass die so ausserordentlich vielen Ausnahmen, die bei diesem Gesetze stattfinden, nicht früher aufgefallen sind, obgleich mehrere derselben schon seit langer Zeit bekannt waren. Nur eine fast einzeln stehende

[1] Berzelius Jahresbericht 17 — 158.
[2] Pogg. Ann. 83 — 435.
[3] Pogg. Ann. 37 — 310.
[4] K. Danske Vid. Selsk. Skrift. [5] — 2 — 54 (1850).
[5] Ann. Chim. Phys. [4] — 30 — 271.

water admits of being evaporated to dryness, and the residue even dried at a temperature of 180° C. without volatilising any considerable quantity of hydrochloric acid. But it is not necessary to seek in the properties of chloride of magnesia the most plausible means of explanation; we need only keep to the carbonate and its properties, as determined by the most renowned Chemists.

According to the statements of Berzelius,[1] H. Rose,[2] Fritzsche,[3] Nörgaard,[4] and L. Joulin,[5] carbonate of magnesia formed at a high temperature invariably contains less carbonic acid than the neutral salt; nay, according to Berzelius and Rose the precipitate resulting from the mixture of carbonate of potash, when cold, with solutions of magnesia, contains less carbonic acid than saturated carbonate of magnesia. For carbonate of magnesia we have a very large number of conflicting statements, and the compounds obtained have been found to vary greatly with the mode of operation, the proportion of their constituents, too, often agreeing but very indifferently with that computed by the formulæ. By some authors these combinations have been regarded as basic salts, varying in their component parts; nay by L. Joulin, as consisting of inconstant mixtures of some oxide and carbonate. I lack space here to notice the numerous memoirs treating of this subject, and shall therefore merely refer the reader to Gmelin-Kraut's 'Handbuch der Chemie' (6te Auflage, 2, p. 432), in which copious extracts from them will be found. I cannot however refrain from quoting certain remarks by H. Rose, on which a short time since I happened to light, — remarks showing science to have been long in possession of materials amply sufficient to explain Dr. Jacobsen's observations. In Pogg. Ann., [3] 23, p. 417, H. Rose observes as follows: —

"Als das Gesetz der einfachen chemischen Proportionen aufgestellt und hinreichend durch Versuche bewiesen worden war, ergab sich die Neutralität zweier sich zersetzender Salzauflösungen als eine ganz natürliche Folge des Gesetzes der bestimmten Verhältnisse, in denen sich alle Körper, also auch Säuren und Basen, mit einander verbinden.

Aber das Gesetz, dass durch Zersetzung zweier neutraler Salze nach ihrer Auflösung in Wasser wiederum zwei neutrale Salze entstehen, ist nicht richtig, wenigstens nicht in der Allgemeinheit, wie es bisher ohne den geringsten Widerspruch angenommen worden ist.

Es ist bemerkenswerth, dass die so ausserordentlich vielen Ausnahmen, die bei diesem Gesetze stattfinden, nicht früher aufgefallen sind, obgleich mehrere derselben schon seit langer Zeit bekannt waren. Nur eine fast einzeln stehende

[1] Berzelius Jahresbericht, 17, p. 158.
[2] Pogg. Ann. 83, p. 435.
[3] Pogg. Ann. 37, p. 310.
[4] K. Danske Vid. Selsk.-Skrift [5] 2, p. 54 (1850).
[5] Ann. Chim. Phys. [4] 30, p. 271.

Ausnahme erregte vor längerer Zeit ein allgemeines Aufsehen. Als man fand, dass eine Auflösung von gewöhnlichem phosphorsaurem Natron, welche für sich geröthetes Lackmuspapier bläut, mit einer Auflösung von salpetersaurem Silberoxyd, welche das Lackmuspapier unverändert lässt, versetzt, einen Niederschlag von gelbem phosphorsaurem Silberoxyd und eine Flüssigkeit giebt, welche gebläutes Lackmuspapier röthet, konnte diese Erscheinung nicht früher genügend erklärt werden, als bis die interessanten Untersuchungen von Clarke, und die sinnreiche Deutung derselben durch Graham bekannt wurde.

Aber vor weit längerer Zeit schon hatte man Erscheinungen beobachtet, die eben so räthselhaft waren, als der beschriebene Fall. Man hatte schon oft bemerkt, dass aus der Auflösung eines neutralen kohlensauren Alkalis durch Zersetzung vermittelst einer Auflösung eines neutralen Salzes von Magnesia, von Zinkoxyd oder von einem andern ähnlich zusammengesetzten Metalloxyd Kohlensäuregas entwickelt werde, besonders wenn die Fällung des kohlensauren Oxyds in der Wärme geschieht, und eine grosse Reihe von Versuchen, die man besonders in neuerer Zeit angestellt hat, hat ergeben, dass die meisten der kohlensauren unlöslichen Salze, welche man durch Zersetzung neutraler Salzauflösungen erhält, nicht die entsprechende Zusammensetzung des kohlensauren Alkalis haben, das zu ihrer Erzeugung angewandt worden ist. Sie enthalten weniger Kohlensäure, aber obgleich die Untersuchungen oft von sehr bewährten Chemikern angestellt worden sind, so hat man ihre Zusammensetzung sehr wenig übereinstimmend gefunden."

H. Rose har ogsaa ved Forsog, som han sammesteds beskriver, fundet, at varmt fældt basisk kulsur Magnesia indeholder mindre Kulsyre, naar den efter Fældningen koges nogen Tid, end naar den strax gjores til Gjenstand for Analyse.

Det kan efter dette ikke være tvivlsomt, at den kulsure Magnesia ved hoiere Temperaturer decomponeres og antager meget forskjellige Sammensætninger, eftersom den koges kortere eller længere Tid. Rigtignok er det ikke nogensteds ved de tidligere Forsog paavist, at man paa denne Maade kan faa Magnesia fuldstændig befriet for Kulsyre, men man maa ogsaa her tage Hensyn til, at man ved de tidligere Forsog visselig overalt har arbeidet med temmelig store Mængder Bundfald, der naturligvis ikke med samme Lethed som Smaaportioner vil kunne erholdes decomponerede.

Forat paavise, at smaa Mængder kulsur Magnesia ved Kogning lader sig omvandle til fuldstændig rent Oxyd, gik jeg frem paa følgende Maade. Af fuldstændig ren friskt udglodet Soda afveiedes 0,422 Gr. og oplostes i 100 CC. kulsyrefrit destilleret Vand, ligeledes tilberedtes en 13 % indeholdende Oplosning af almindelig ren svovlsur Magnesia, som i Forveien ved gjentagne Omkrystallisationer var befriet for alle Forurensninger. En Blanding af 15 CC. af Sodaoplosningen med 50 CC. af Bittersaltoplosningen fortyndet med noget over $^1/_4$ Litre friskt udkogt endnu varmt Vand kogtes i en kulsyrefri Luftstrom i Classens

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Moreover, H. Rose also found, by experiments which he has described in the same paper, that basic carbonate of magnesia, precipitated warm, contains less carbonic acid when boiled for some time after precipitation than when at once subjected to analysis.

From what has been stated above, carbonate of magnesia is evidently decomposed at a high temperature, and enters into a variety of very different combinations according to the duraton of the boiling-process. True, none of the earlier experiments have shown that all the carbonic acid present in magnesia can be expelled by this method; but those experiments were conducted, we must remember, with a comparatively large amount of precipitate, which necessarily proves less easy to decompose than do small quantities.

In order to show that small quantities of carbonate of magnesia may be transformed by boiling into pure oxide, I went to work as follows. In 100^{cc} of distilled water free from carbonic acid were dissolved 0,422^{gr} of freshly heated carbonate of soda; a solution was likewise prepared containing 13 per cent of ordinary sulphate of magnesia, which by repeated crystallization had been previously freed from all impurities. A mixture consisting of 15^{cc} of the solution of soda and 50^{cc} of a solution of Epsom salts diluted with a little more than $^1/_4$ of a litre of freshly boiled water, still warm, was boiled in Classen's ap-

Apparat i omkring 2 Timer, idet den undvigende Kulsyre som for opfangedes og bestemtes ved titreret Barytvand. I den anvendte Mængde Sodaoplosning var indeholdt 63.3 Mgr. Soda svarende til 26.3 Mgr. Kulsyre, medens der ved to Experimenter paa denne Maade fandtes uddrevet den ene Gang 26.8 og den anden 27.7 Mgr. Ved Forsogets Gjentagelse med en lidt større Qvantitet paany indveiet Soda fandtes uddrevet 34.1 Mgr. Kulsyre istedetfor beregnet 33.2. Under Kogningen var Oplosningen i Begyndelsen fuldstændig klar, hvorpaa der efter circa $^1/_2$ Times Forløb begyndte at fremkomme et Bundfald af Magnesia, hvori der trods al anvendt Moie ikke lykkedes mig at paavise det mindste Spor af Kulsyre. Den basisk kulsure Magnesia er nemlig ifølge H. Rose og Flere ikke ubetydelig opløselig saavel i Vand som i forskjellige Salte, saaledes at der af smaa Mængder intet Bundfald fremkommer, og det er derfor ikke paafaldende, at Oxydet ved saa fortyndede Opløsninger, som her ere anvendte, ikke udfældes, førend det ved Kogningen er befriet for sin Kulsyre.

Koges Søvand under Concentration, kan man meget let komme til at overse denne Udskillelse af Magnesia, idet denne først indtræder efter nogen Tids Forløb, saaledes at man kan antage Blakningen fremkommen ved Udfældning af Gips i den concentrerede Vædske. Udskillelsen vil ogsaa, naar Inddampningen foregaar i aabent Kar, forsinkes betydeligt, idet Kulsyrens Undvigen foregaar meget langsommere i en kulsyreholdig Atmosphære end i en kulsyrefri Luftstrøm, og det kan derfor ikke forundre, at denne Udfældning af Magnesia af kogende Søvand, saavidt mig bekjendt, ikke tidligere er observeret, naar undtages, at Usiglio[1] i det tørrede Residum har paavist fri Magnesia. Dersom man imidlertid koger Søvand uden Concentration i en kulsyrefri Atmosphære med omvendt Kjøler, saaledes som det let kan ske ved Classens Apparat, fremtræder Phænomenet meget tydeligt paa samme Maade som ved Kogning af en Blanding af Soda og Bittersalt, idet der efter circa $^1/_2$ Times Kogning begynder at udskille sig et Bundfald bestaaende af ren kulsyre- og kalkfri Magnesia ved Siden af et lidet Spor af Kiselsyre hidrørende fra det benyttede Glaskar. Om man samtidig opfanger og bestemmer den undvigende Kulsyre, viser det sig, at den Villighed, hvormed Kulsyren undviger, ikke saameget afhænger af Concentrationsgraden som af Varigheden af det Tidsrum, hvori Kogningen fortsættes, da ogsaa paa denne Maade circa 2 Timers Kogning strækker til for at skaffe en fuldstændig kulsyrefri Vædske.

Det vil forhaabentlig hermed kunne ansees fuldstændig godtgjort, at Søvandets Evne til ved Kogning at decom-

[1] Journ. für pract. Chem. 46 — 106.

paratus for 2 hours exposed to a current of air free from carbonic acid, the carbonic acid driven off being collected and determined as before by titrated baryta water. The portion of the solution of carbonate of soda employed contained 63.3^{mgr} of that substance, representing 26.3^{mgr} carbonic acid; and two experiments performed by this method gave respectively 26.8^{mgr} and 27.7^{mgr} as the amount of the latter driven off. On repeating the experiment with a somewhat larger quantity of carbonate of soda, carefully weighed, 34.1^{mgr} were found to have been liberated, whereas the exact proportion would have been 33.2^{mgr}. During the process of boiling, the fluid at first continued perfectly clear; but after the lapse of about half an hour magnesia began to be precipitated, in which with the most delicate tests I failed to detect the smallest trace of carbonic acid. According to H. Rose and other authors basic carbonate of magnesia is to a considerable extent soluble alike in water and in solutions of divers salts, so that small quantities give no precipitate; and hence it is not surprising that with a solution so diluted as that made use of for these experiments, the oxide should not have been precipitated before it had given off all its carbonic acid.

If sea-water be boiled during concentration, this precipitation of magnesia may be easily overlooked, since it does not take place till after the lapse of some time, and the turbidness of the concentrated fluid might therefore be ascribed to the deposit of gypsum. When the water, too, is evaporated in an open dish, the precipitation will be considerably retarded, since the carbonic acid escapes much more slowly in an atmosphere containing carbonic acid than in a current of air from which all carbonic acid has been expelled; and this accounts for the precipitation of magnesia in boiled sea-water, so far as I am aware, not having been previously observed, except at least by Usiglio,[1] who detected the presence of free magnesia in the dried residue. When, however, sea-water is boiled without being concentrated in an atmosphere free from carbonic acid, and with the cooler inverted, which it easily may be with Classen's apparatus, the phenomenon appears with great distinctness, as is the case on boiling a mixture of soda and Epsom salts; for after about half an hour's boiling a precipitate begins to form, consisting of pure magnesia, with no admixture of lime and carbonic acid and a trace only of silicic acid, the latter arising from the glass vessel employed in the operation. If the carbonic acid be simultaneously collected and determined, the readiness with which it escapes is found to depend not so much on the degree of concentration as on the duration of the boiling-process, about 2 hours proving amply sufficient to obtain a fluid free from the smallest trace of carbonic acid.

From what has been stated, there is, we think, conclusive proof, that the property possessed by sea-water of

[1] Journ. für pract Chem. 46, p. 106.

ponere neutrale Carbonater maa blive at tilskrive gradvise Omsætninger mellem de i Søvandet existerende kulsure Salte og Magnesiaforbindelserne, og de af Dr. Jacobsen hos Søvandet iagttagne Egenskaber maa derfor ogsaa i mere eller mindre Grad tilligge alle andre magnesiaholdige Mineralvande, eller naar man lægger Roses ovenciterede Udtalelser til Grund, alle Saltoplosninger, forsaavidt de foruden Alkalier og Jordalkalier tillige indeholder oplöselige Salte af nogen af de svagere Baser, som med Kulsyren danner ubestandige Forbindelser. Denne Omstændighed vil saaledes uden videre stemple saa godt som alle de til Bestemmelse af Forholdet mellem den frie og bundne Kulsyre i Mineralvande anvendte talrige Methoder som mere og mindre upaalidelige ligeoverfor magnesiaholdige Mineralvande, idet man ved dem til Bestemmelse af neutralbunden Kulsyre enten anvender Residuet fra Inddampning eller paa anden Maade benytter sig af Kogning, hvor den efter det forhen udviklede vil være utilladelig.

Det vil sluttelig ikke være paa urette Sted kortelig at berøre de Synsmaader, som fra ældre Tider har været gjort gjældende, hvad angaar de i Søvandet indeholdte Carbonater.

Efter de Fremgangsmaader, hvorved disse af ældre Forfattere ere bestemte, kunde de naturligvis kun erholdes udskilte i Form af kulsur Kalk eller, som af enkelte ogsaa fundet, lidt kulsur Magnesia, men deraf følger ingenlunde, at de med Nødvendighed oprindelig skulde forekommet i Søvandet under denne Form, ja dette er saa langt fra sikkert, at jeg meget mere skulde være tilbøielig til at tro, at saa ikke er Tilfælde. Koger man nemlig Søvand i det af Dr. Jacobsen beskrevne Luftudkogningsapparat, undviger der, som allerede før bemærket, meget smaa Qvantiteter Kulsyre, idet man kan fortsætte Kogningen med vexlende Afkjøling en hel Time uden at faa uddrevet mere end en Brøkdel af Milligram pr. Litre. Kogepunctet vil her i Begyndelsen ligge meget lavt, men stiger, efterhaanden som den undvigende Luft og den dannede Vanddamp forøger Trykket, meget hurtigt, saaledes at jeg allerede under den første Halvdel af Operationen har observeret en Temperatur af 89° C. Naar saaledes de i Søvandet indeholdte sure Carbonater vise en saa haardnakket Modstand mod Decomposition, at de i en hel Time skulde saa godt som aldeles uden Virkning kunne udsættes for en Temperatur af omkring 90° C., da synes mig denne Egenskab at passe noget bedre paa surt kulsurt Natron end paa sur kulsur Kalk, og det vilde desuden falde vanskeligt at forklare Søvandets tydelige alkaliske Reaction, medmindre man kunde antage, at Carbonaterne i det Mindste for en ikke ringe Del bestod af Alkalisalte.

Med Hensyn paa Qvantiteten af de i Søvandet forekommende kulsure Salte, da stemme de derover existerende Opgaver meget daarligt overens, de lyde i Regelen paa Spor undertiden endog paa Intet, medens der af enkelte igjen er opført forholdsvis store Mængder. Saaledes finder

decomposing when boiled neutral carbonates, arises from the slow reciprocal action of the carbonates and salts of magnesia it contains, and the properties observed by Dr. Jacobsen in sea-water must therefore to a greater or less extent distinguish all mineral waters containing magnesia compounds, or, according to Rose, in his statements quoted above, all solutions of salts, provided they contain, exclusive of sodium, potassium, lime, barium, and strontium, also soluble salts of some one of the weaker bases, which along with carbonic acid form inconstant combinations. Hence, this circumstance clearly shows, that of the numerous methods devised for determining, in mineral waters, the relative proportion of free carbonic acid and that present in carbonates nearly all are, when magnesia is present, unreliable, since for the determination of the carbonic acid present in carbonates, either the residue from evaporation or some other result of boiling is had recourse to, which has been shown to be inadmissible.

Finally, it will not be out of place to notice the views originally entertained with regard to the carbonates present in sea-water.

By the process according to which the earlier chemists determined these compounds, they could of course obtain them only in the form of carbonate of lime, or, as found by some observers, along with a little carbonate of magnesia; but from this it does not by any means follow that they necessarily occur in that form in sea-water; nay, I am myself inclined to believe that such is not the case. On boiling sea-water in the apparatus described by Dr. Jacobsen, very small quantities only of carbonic acid are found to escape; the fluid may be alternately boiled and cooled for an hour together without liberating more than a fraction of a milligramme per litre. The boiling-point with this method will at first be very low, but, on the pressure being increased by the escape of the air and the formation of steam, rapidly rise; even in the first half of the operation I have observed a temperature of 89° C. The vigorous resistance to decomposition thus exhibited by the bicarbonates in sea-water, which admits of their being exposed almost without effect for an hour together to a temperature of nearly 90° C., would rather seem to indicate bicarbonate of soda than bicarbonate of lime; and besides, the decided alkaline reaction of sea-water would be difficult to explain unless by assuming the carbonates — or a considerable portion of them at least — to consist of carbonate of soda and potash.

With regard to the proportion of carbonates present in sea-water, the results as yet obtained agree but very indifferently; the majority of observers have detected traces only or none whatever, whereas some allege to have found comparatively large quantities, as will be seen from the following Table.

von Bibra[1] Intet.
Robinet og Lefort[2] i det røde Hav Spor.
Pisani[3] ved Bujuk-Déré i Bosporus 0.1569 Gr. pr. Litre.
C. Knauss[4] 0.011 Gr. pr. Litre.
Thorpe og Morton[5] i det irske Hav 0.04754 i 1000 Dele Vand.
Dr. Jacobsen i Nordsøen 0.018—0.028 Gr. pr. Litre.
Vierthaler[6] i Adriaterhavet 0.315 Gr. pr. Litre.
F. Wibel[7] i det joniske Hav Intet
og Buchanan[8] i de sydlige Have enten Intet eller og meget smaa Mængder.

Saa store Forskjelligheder vilde naturligvis være meget paafaldende, i Fald man kunde anse Resultaterne af disse Observationer for aldeles correcte, hvad der imidlertid ikke er muligt, da alle uden Undtagelse ere udførte efter Methoder, som kun for aldeles specielle Sammensætninger af Havvandet kunde føre til nogenlunde rigtige Resultater.

Ved de tidligere i denne Afhandling beskrevne Forsøg er det godtgjort, at Søvandet (under enhver Omstændighed det af Forfatteren undersøgte) ved Kogning i kulsyrefri Luft taber al neutralbunden Kulsyre, og det maa endvidere ved de af v. Bibra og Buchanan udførte Observationer ansees fuldt bevist, at almindeligt Oceanvand ved Inddampning til Tørhed selv i en kulsyreholdig Atmosphære undertiden kan give et fuldstændig kulsyrefrit Residuum, medens det kanske ligesaa ofte ikke vil være Tilfælde, idet der ofte af Buchanan og altid af Jacobsen er fundet Carbonater i Residuet. Hvor den neutralbundne Kulsyre under Inddampningen bortdrives, vil der til Gjengjæld altid udfældes den æqvivalente Mængde Magnesia, som, naar Residuet henstaar i kulsyreholdig Luft før Bestemmelsen, vil kunne gjenoptage en Del Kulsyre, og det er derfor let forklarligt, at man ved Anvendelse af Inddampning vil kunne erholde meget forskjellige Resultater selv i Søvand af fuldstændig identisk Sammensætning.

En til Bestemmelse af Carbonaterne hyppig anvendt Methode er den, hvorefter Søvandet koges i ca. 1 Time under stadig Fornyelse af det fordunstede Vand, hvorefter det udskilte Bundfald frafiltreres og veies, saaledes som Vierthaler og flere har gjort, medens T. E. Thorpe og E. H. Morton af den i Søvandet oprindelig indeholdte Kalkmængde og den i Vædsken efter Frafiltration af det ved Kogningen udskilte Bundfald tilbageværende beregner den kulsure Kalks Mængde.

[1] Ann. Chem. Pharm. 77 — 90.
[2] Compt. rend. 62 — 436.
[3] Compt. rend. 41 — 532.
[4] Petersb. Acad. Bull. 2 — 203 (1860).
[5] Ann. Chem. Pharm. 158 — 122.
[6] Wien. Acad. Ber. [2] — 56 — 479.
[7] Ber. Berl. chem. Ges. 6 — 184.
[8] Proc. Roy. Soc. 24 — 604.

Von Bibra:[1] none.
Robinet and Lefort,[2] in the Red Sea: traces.
Pisani,[3] near Bujuk-Déré in the Bosporus: 0.1569^{gr} per litre.
C. Knauss:[4] 0.011^{gr} per litre.
Thorpe and Morton,[5] in the Irish Sea: 0.04754 in 1000 parts of water.
Dr. Jacobsen, in the North Sea: 0.018—0.028^{gr} per litre.
Vierthaler,[6] in the Adriatic Sea: 0.315^{gr} per litre.
F. Wibel,[7] in the Ionian Sea: none.
Buchanan,[8] in the Southern Seas: none at all or traces only.

Differences so considerable would indeed be extraordinary, assuming the results of the observations to be quite correct; this, however, is simply impossible, since they were all without exception obtained by methods none of which, save for sea-water of a particular composition, can lead to results even approximately reliable.

By the experiments previously described in this Memoir, it has been shown that sea-water — at least that examined by the author — can, by boiling in an atmosphere free from carbonic acid, be made to part with all of its carbonic acid that is present in carbonates; and moreover, the observations of v. Bibra and Buchanan have furnished conclusive proof, that ordinary ocean-water when evaporated to dryness even in a atmosphere containing carbonic acid, sometimes gives a residue in which no trace of carbonic acid can be detected, but the reverse will, perhaps, no less frequently prove to be the case, seeing that Buchanan has often, and Jacobsen always, found carbonates present in the residue. When the neutral carbonates are decomposed during the process of evaporation, an equivalent proportion of magnesia will invariably be precipitated, which, on the residue being allowed to stand over previous to determination in an atmosphere containing carbonic acid, may, possibly absorb some carbonic acid; and hence, when recourse is had to evaporation, very different results may obviously be obtained even with water identical in composition.

A method frequently adopted for determining the proportion of carbonates, is to boil the sea-water for about an hour, while steadily adding freshwater in place of that evaporated, after which the precipitate is filtered off and weighed, as done by Vierthaler and others; T. E. Thorpe and E. H. Morton calculate the proportion of carbonate of lime by comparing the amount of lime originally present in the water with that contained in the fluid after filtering off the precipitate.

[1] Ann. Chem. Pharm. 77, p. 90.
[2] Comp. rend. 62, p. 436.
[3] Comp. rend. 41, p. 532.
[4] Petersb. Acad. Bull. 2, p. 203 (1860).
[5] Ann. Chem. Pharm. 158, p. 122.
[6] Wien. Acad. Ber. [2] 56, p. 479.
[7] Ber. Berl. chem. Ges. 6, p. 184.
[8] Proc. Roy. Soc. 24, p. 604.

Det er af samme Grund som ovenfor klart, at denne Fremgangsmaade for almindeligt Oceanvands Vedkommende vil føre til aldeles værdiløse Resultater, uden at det dog med Sikkerhed kan paastaaes, at dette i samme Udstrækning skulde være Tilfælde for det af Vierthaler undersøgte Vand, som har en fra almindeligt Søvand meget forskjellig Sammensætning. Efter de talrige og værdifulde Analyser af Søvand, som vi skylde Professor Forchhammer, indeholder Vandet i de store Verdenshave uden synderlig store Variationer i de enkelte Bestanddeles indbyrdes Forhold gjennemsnitlig

Chlor + Brom	1.895 %
Svovlsyre (SO_3)	0.225 -
Magnesia	0.210 -
Kalk	0.056 -

medens Vierthaler i Adriaterhavet har fundet

Chlor + Brom	2.264 %
Svovlsyre	0.262 -
Magnesia	0.237 -
Kalk	0.371 -

Denne uforholdsmæssig store Forøgelse af Kalkmængden uden tilsvarende Forøgelse af Svovlsyremængden vil bidrage til, at det af Vierthaler undersøgte Vand vil have en meget større Tilbøielighed til ved Kogning at udskille kulsur Kalk, hvad der i ikke ringe Grad kan tænkes at forrykke de almindelige Phænomener.

Hvad angaar de af Thorpe og Morton udførte Observationer, da er der i en Henseende en væsentlig Forskjel mellem de af disse Forfattere og de af mig erholdte Resultater. Jeg havde, allerede før jeg blev opmærksom paa den af dem offentliggjorte Afhandling, lagt Mærke til, at der af Søvand ved Kogning i en kulsyrefri Luftstrom i Classens Apparat udfældtes et Bundfald af Magnesia, indeholdende lidt fra Glasset hidrørende Kiselsyre, men jeg havde aldrig deri kunnet paavise hverken Kulsyre eller Kalk og det, uanseet om Kogningen afbrødes paa et tidligere eller senere Stadium, hvadenten den neutralbundne Kulsyre var helt eller kun delvis bortdrevet. Rigtignok anfører Thorpe og Morton intetsteds udtrykkelig, at de have undersøgt det udskilte Bundfald paa Kalk, men det fremgaar indirecte med stor Bestemthed, af hvad der forresten er bemærket, at saa maa have været Tilfælde.

At Vierthaler kunde faa udfældt kulsur Kalk af et saa abnormt sammensat Søvand som det i Adriaterhavet flydende, kunde ikke vække Forundring, men at det samme fandtes at være Tilfælde med Vandet i det irske Hav, som ved livlige Strømme stadig optager friske Vandmængder fra det store Verdenshav, og som i sin Sammensætning viser sig saa analogt det af den norske Nordhavsexpedition undersøgte, forekom mig meget paafaldende. Jeg har derfor gjentaget Thorpe og Mortons Forsøg aldeles uforandrede paa flere af de fra den norske Expedition hjembragte Vandprøver, men erholdt altid det samme Resultat, at det i det udskilte Bundfald trods al anvendt Møie ikke lykkedes at paavise Spor hverken af Kulsyre eller Kalk. Af det forhen Udviklede vil det fremgaa, at man af de ældre Angi-

For the same reason, as explained above, the said process with ordinary ocean-water will give results absolutely worthless; this cannot however be affirmed with certainty of Vierthaler's observations, the water he examined having been very different in composition from ordinary sea-water. According to the numerous and valuable analyses of sea-water for which we are indebted to Professor Forchhammer, the water of the great oceans, the component parts of which vary but little in their relative proportion, is generally found to contain —

Chlorine + Bromine	1.895 per cent.
Sulphuric Acid (SO_3)	0.225 - —
Magnesia	0.210 - —
Lime	0.056 - —

whereas the water of the Adriatic Sea, according to Vierthaler's observations, contains —

Chlorine + Bromine	2.264 per cent.
Sulphuric Acid	0.262 - —
Magnesia	0.237 - —
Lime	0.371 - —

This disproportionately large amount of lime without a corresponding increase in the amount of sulphuric acid will give the water examined by Vierthaler a tendency, when boiled, to precipitate carbonate of lime, which must to a considerable extent have a disturbing influence on the phenomena.

With regard to the series of observations instituted by Thorpe and Morton, there is, in one respect, an essential difference between their results and mine. Previous to my reading their Memoir, I had become aware of the fact, that, on boiling sea-water exposed to a current of air free from carbonic acid in Classen's apparatus, there results a precipitate of magnesia, containing a little silicic acid, derived from the glass; but I have never succeeded in detecting therein the presence of carbonic acid or lime: the result is precisely the same whether the boiling be interrupted at an early or a late stage of the process, or whether all or part only of the carbonates be decomposed. True, Thorpe and Morton nowhere distinctly state their having examined the precipitate for lime; but from what is observed in other respects, this must obviously have been the case.

That Vierthaler should have succeeded in precipitating carbonate of lime from water so exceptionally composed as is that of the Adriatic Sea, cannot surprise us; but that the same result should have been obtained with water from the Irish Sea, which by reason of rapid currents is continually receiving a large influx of water from the Atlantic Ocean, and which in its composition exhibits so great an analogy with that examined on the Norwegian North-Atlantic Expedition, does, to me, indeed appear strange. I have therefore repeated the experiments instituted by Thorpe and Morton, adopting their method without the slightest modification; but the results obtained were invariably the same: even with the most delicate tests I failed to detect the smallest traces of carbonic acid or

velser Intet med Bestemthed kan slutte om Carbonaternes Mængde i de store Verdenshave. Dèt synes dog, som om de af Buchanan udførte Bestemmelser af Kulsyren i Atlanterhavet, (hvorved han inddamper efter forudgaaende Tilsætning af Chlorbarium og tilslut med stærk Saltsyre forgjæves har bestræbt sig for at paavise Kulsyre i Residuet), med Sikkerhed skulde fastsætte en øvre Grændse for den tilstedeværende Carbonatmængde, men dette er i Virkeligheden ikke Tilfælde.

Som bekjendt beskytter uopløselige Sulfater Carbonater mod Decomposition endog, naar til Uddrivelse af Kulsyren anvendes saa radicale Midler som concentreret Svovlsyre, saaledes at man endog af den Grund har fundet det fornødent at modificere den af Fresenius og Will angivne Methode til Bestemmelse af Kulsyren i neutrale Carbonater.[1] De af Buchanan foretagne Undersøgelser efter Kulsyre i Residuet kan derfor ikke betragtes som Bevis for, at den ikke skulde have været tilstede, og det fremgaar ogsaa tydeligt af hans egne Udtalelser, at han selv har været af samme Mening.

Forat faa Rede paa, hvorvidt en ved Kogning bevirket Decomposition af de i Søvandet indeholdte neutrale Carbonater foregaar i større Udstrækning ogsaa, naar der i Vædsken findes uopløselige Sulfater, har jeg udført nogle Forsøg efter den af Buchanan foreslaaede Fremgangsmaade. Af nogle Vandprøver, som, undersøgte efter den af mig benyttede Methode, viste sig at indeholde en Sum af surt- og neutralbunden Kulsyre af 96 Mgr. pr. Litre og derover, erholdtes ved Inddampning til Tørhed efter Tilsætning af Chlorbarium uddrevet kun henimod 50 Mgr., ved en enkelt Undtagelse erholdtes engang over 50 Mgr. pr. Litre. Det vil sige, den uddrevne Kulsyremængde var ikke synderlig høiere end den af Buchanan for Vandet i Æqvatoregnene angivne og beløb sig til kun faa Mgr. over, hvad den surtbundne Kulsyre efter paalidelige Observationer skulde beløbe sig til, de endnu i Residuet tilbageværende Carbonater lykkedes det heller ikke mig at paavise.

Spørgsmaalet om Carbonaternes Mængde i de sydlige Have maa derfor endnu betragtes som aabent.

Forhaabentlig resterer endnu en Del af de fra Challengerexpeditionens Togter hjembragte Vandprøver, og man vil i saa Fald ved Undersøgelse af disse kunne give Bidrag til Besvarelsen af disse Spørgsmaal.

Efterat Ovenstaaende var nedskrevet paa Norsk, men førend det endnu var oversat paa Tysk, ankom hertil 2det og 3die Hefte for 1879 af Fresenius' Zeitschrift für anal. Chem., hvori E. Bohlig offentliggjør en Afhandling,[2] hvoraf det sees, at han ved Arbeide med naturlige Mineralvande har observeret Omsætninger mellem kulsur Kalk og svovl-

[1] Fresenius, Qvant. Analyse, 5te Aufl. 364 bb.

[2] Fresenius' Zeitschrift, 18 — 195.

of lime. From what has been already explained, it is obvious that nothing definite can be inferred from earlier statements respecting the proportion of carbonates in the water of the great oceans. The carbonic acid determinations performed by Buchanan with water from the Atlantic Ocean (he had recourse to evaporation, adding first chloride of barium, and then attempting, unsuccessfully, to detect carbonic acid in the residue by means of strong hydrochloric acid) would appear to fix a limit for the maximum amount of carbonates contained in sea-water; but such is not really the case.

The presence of insoluble sulphates serving, as is known, to protect carbonates against decomposition, even when concentrated sulphuric acid is made use of to expel the carbonic acid, it was necessary for this reason alone to modify the process devised by Fresenius and Will for determining carbonic acid in neutral carbonates.[1] Hence, the experiments performed by Buchanan with a view to detect carbonic acid in the residue, cannot be regarded as affording conclusive proof of its absence; indeed, he himself, as appears from his statements, is clearly of the same opinion.

In order to ascertain whether the decomposition by boiling of the neutral carbonates in sea-water also took place to a considerable extent when insoluble sulphates were present in that fluid, I made a few experiments by Buchanan's process. From several samples of sea-water which, examined by the method I adopted, were found to contain 96^{mgr} of carbonic acid per litre, I succeeded, by evaporation to dryness, after adding a solution of chloride of barium, in liberating about 50^{mgr} only, with a solitary exception, when the amount exceeded 50^{mgr} per litre. The proportion of carbonic acid expelled was accordingly not much greater than that determined by Buchanan in water from the Equatorial Seas, and but a few millegrammes in excess of what the carbonic acid forming bicarbonates, according to trustworthy observations, should have been; of the carbonates said to be still present in the residue, I failed to detect any trace.

The amount of the carbonates contained in the water of the Southern Seas must, therefore, be still regarded as an open question.

It is to be hoped, that some of the samples of water collected on the 'Challenger' Expedition still remain, in which case their examination will serve to throw further light on the subject.

After this Memoir had been written in Norwegian, but previous to its translation into German, the 2nd and 3rd Parts of Fresenius' Zeitschrift für anal. Chemie for 1879 came to hand, in which E. Bohlig has published a paper[2] on transformations, observed by him in mineral waters, resulting from the reciprocal action of carbonate of

[1] Fresenius, Qvant. Analyse, 5te Aufl. 364, bb.

[2] Fresenius' Zeitschrift, 18, p. 195.

sur Magnesia, som fuldstændig svare til, hvad jeg efter de foran beskrevne Observationer har fundet for Søvands Vedkommende. Disse Omsætninger kunne saaledes, idet de ere iagttagne af to af hinanden uafhængigt arbeidende Chemikere, uden videre Begrundelse antages fuldstændig factiske.

Det vil af dette Bohligs Arbeide sees, at han allerede Sommeren 1878 over det samme Thema har publiceret en Afhandling,[1] som jeg ikke tidligere har været opmærksom paa. Den vilde dog ikke havt nogen væsentlig Indflydelse paa mine Undersøgelser, saasom de vigtigste af de Observationer, der har ført mig frem til de samme Resultater, som Bohlig først har beskrevet, allerede vare udførte 3—4 Maaneder, førend hans første Afhandling forelaa trykket.

[1] Fresenius' Zeitschrift, 17 — 301.

lime and sulphate of magnesia, which precisely agree with those I have described as occurring in sea-water. These transformations having accordingly been observed by two chemists working independently of each other, may without further proof be accepted as facts.

From the said paper, it appears that Bohlig published a treatise on the same subject in the summer of 1878,[1] to which my attention had not previously been directed. It would not, however, have materially influenced my experiments, the most important of the observations that led me to the results which Bohlig was the first to describe, having been instituted 3 or 4 months before his first treatise had left the press.

[1] Fresenius' Zeitschrift, 17, p. 301.

III. Om Saltholdigheden af Vandet i det norske Nordhav.

Hvor det gjælder at tilveiebringe Oplysninger om Variationerne af Saltmængderne i Havvandet, kan man til sine Saltbestemmelser benytte flere forskjellige Methoder, som hver især tidligere har fundet udstrakt Anvendelse. Den nærmest liggende af disse bestaar i Vandets Afdampning og derpaa følgende Tørring og Veining af de som Residuum tilbageblivende Salte, en Fremgangsmaade, som rigtignok directe fører til Maalet, men som til Gjengjæld ogsaa fordrer temmelig meget Arbeide. Som mere indirecte men ogsaa ulige mindre besværlige Methoder kan ogsaa anvendes Bestemmelse af Havvandets Chlormængde[1] eller Egenvægt, hvoraf man gjennem passende bestemte Coefficienter kan beregne den samlede Saltmængde, forudsat, at man kan antage et constant indbyrdes Forhold mellem de i Søvandet indeholdte faste Bestanddele. Den første af disse Methoder medfører foruden Besværligheder ved Udførelsen ogsaa den Ulempe, at den ikke lader sig anvende ombord paa et Fartøi i aaben Sø, hvor Skibets Bevægelser forbyder Brugen af Vægt, medens Egenvægtsbestemmelser ved Hjælp af Aræometre og volumetriske Chlorbestemmelser meget letvindt og med temmelig stor Nøiagtighed kan udføres ombord selv i temmelig uroligt Veir.

Hvor man derfor ikke tror sig sikker paa at kunne opbevare Vandprøverne i længere Tidsrum uden derved at risikere, at de undergaa Forandringer, som kunde ytre en skadelig Indflydelse paa Resultaterne af de erholdte Saltbestemmelser og, hvor man som Følge deraf maa lægge Hovedvægten paa en hurtig Undersøgelse af Vandprøverne i frisk Tilstand, bliver man saaledes udelukkende henvist til Brugen af Chlorbestemmelser eller Egenvægtsbestemmelser som Maal for den samlede Saltgehalt.

Paa det første af den norske Expeditions Togter blev af Svendsen, hvem de chemiske Observationer dengang vare

[1] Saavel her som overalt senere forstaaes ved Chlormængde den samlede Chlor- og Brommængde.

III. On the Amount of Salt in the Water of the Norwegian Sea.

When seeking to investigate the degree in which the proportion of salt varies in sea-water, choice may be made for performing the salt-determinations between several methods, each of which has in turn been extensively adopted. The most simple process, is first to evaporate the water, and then dry and weigh the salts left in the residue, a mode of operation which, though leading direct to the desired result, involves considerable labour. Two other methods, not so direct, but far less tedious, consist in determining either the specific gravity of the water or the amount of chlorine[1] it contains, from which, by means of proper coefficients, the total amount of salt may be computed, provided always that a constant proportion can be assumed to exist between the solid constituents of sea-water. The first process is attended, irrespective of the troublesome mode of operation, with another drawback, viz. the impractibility of adopting it on board ship in the open sea, where the motion of the vessel altogether precludes the use of the balance, whereas both specific gravity determinations, with the hydrometer, and volumetric determinations of chlorine, may be performed at sea with the greatest ease, and very considerable accuracy, even in comparatively rough weather.

Hence, when there is reason to fear that the samples of water cannot be preserved for any length of time without exposing them to chemical change, which might exert a disturbing influence on the results; and whenever, accordingly, weight must be chiefly attached to their immediate examination, the only practicable standard of measurement for computing the total amount of salt will be that furnished by determinations of chlorine, or of specific gravity.

On the first voyage of the Norwegian Expedition, Svendsen, who then, as previously stated, did the chemical

[1] By "the amount of chlorine," here and elsewhere throughout this Memoir, is understood the total amount of chlorine and bromine.

overdragne, til Undersøgelser over Saltgehalten udelukkende anvendt Egenvægtsbestemmelser, hvorimod jeg paa de to sidste Togter ved Siden af disse ogsaa har udført et større Antal Chlortitreringer for gjennem denne Control at give Resultaterne en større Sikkerhed.

Til Undersøgelser over den i Søvandet indeholdte Chlormængde medhavdes paa de to sidste Togter foruden Sølvopløsning af saadan Styrke, at 1 CC. af denne omtrent svarede til 1 CC. Søvand, ogsaa 2 paa første Togt indsamlede Vandprøver, bestemte til som Normaler at tjene til den nøjagtigere Fastsættelse af Sølvopløsningens Styrke. Disse Normalers Chlormængde i Procenter blev ved omhyggeligt udførte Veiningsanalyser hvert Aar bestemt saavel for Expeditionens Udreise som efter dens Hjemkomst bestandig med meget nær det samme Resultat, hvorhos tillige deres Egenvægter ved Hjælp af Aræometret ombord aflæstes. Til Brug ved alle ombord udførte Chlortitreringer tjente kun to Büretter af lignende Construction og Størrelse, de samme, som af Stipendiat A. Helland anvendtes ved de Bestemmelser af Chlormængderne i Overfladevandet i Atlanterhavet, som denne foretog i Aaret 1875 paa en Reise til Grønland, de bleve af ham den Gang calibrerede ved Hjælp af Kviksølv og befundne særdeles tjenlige for Øiemedet.

Ved Büretternes Brug fyldtes den ene med Sølvopløsning den anden med det til Undersøgelse bestemte Søvand, hvorefter en passende Portion Søvand fra den ene under Omrystning tilsattes Sølvopløsning fra den anden, indtil al Chlor var udfældt, idet chromsurt Kali tjente som Index. Begge Bürettens Stand aflæstes nu, og nogle Draaber Søvand tilsattes atter til Affarvning, hvorefter paany fulgte Tilsætning af Sølvopløsning og Aflæsning af Büretternes Stand o. s. v. Gjennem en Række af 4 à 5 paa hinanden følgende lignende Aflæsninger erholdtes paa denne Maade de fornødne Data til Beregning af det Volum Søvand, som i hvert enkelt Tilfælde svarede til 1 CC. Sølvopløsning.

Paa denne Maade sammenlignedes paa den ene Side Søvandsprøverne og paa den anden Side ogsaa fra Tid til anden de medbragte Normaler med Sølvopløsningen, idet der altid sørgedes for, at Vandprøvernes og Opløsningernes Temperatur ikke fjernede sig synderlig meget fra hinanden. Bürretterne bleve for at tilveiebringe en bedst mulig Afløbning hyppig rensede med concentreret Svovlsyre.

Af de gjennem disse Observationer erholdte Tal er senere Søvandets Chlormængde beregnet efter følgende Formel

$$p = \frac{K S P}{k s}$$

hvori p betegner den undersøgte Vandprøves Chlormængde i Procenter, k det Antal CC. af samme, der svare til 1 CC. Sølvopløsning og s dens Egenvægt ved 17.°5 C., P Middeltallet mellem de før Udreisen og efter Hjemkomsten i Normalen fundne Chlormængder, K det Antal CC., som af denne svarer til 1 CC. Sølvopløsning og S dens Egen-

work, made exclusive use of specific gravity determinations; but for a considerable number of my own observations, on the last two cruises, I also adopted titration for chlorine as a means of testing the general accuracy of the results.

For estimating the amount of chlorine in sea-water, I took with me, on the two last cruises, besides a solution of silver of such strength that 1^{cc} of the fluid about corresponded to 1^{cc} of sea-water, also 2 samples of water collected on the first voyage, to serve as a normal standard by which to determine the strength of the solution of silver. Each year, both previous to the departure of the Expedition and after its return, the chlorine in these standard samples was carefully determined by weighing, and the percentage calculated accordingly, their specific gravity too, as shown by the areometer on board, having been likewise noted down. For all chlorine-titrations performed at sea, there were only two burettes in use, similar alike in size and construction, — those used by Mr. Helland for determining the amount of chlorine in the surface-water of the Atlantic on a voyage to Greenland in 1875; he had calibrated them by means of mercury, and they proved excellently adapted for the purpose.

When using the burettes, one was filled with solution of silver and the other with the sea-water selected for examination, after which solution of silver was added to a proper quantity of the sea-water, while shaking the flask in which the titration was performed till all chlorine had been precipitated, chromate of potassium serving as the index. The height of the fluid in both burettes was now read, and a few drops of sea-water added to the mixture, to discolour it, after which solution of silver was again added, and the height of the fluids read as before, &c. After the height had been thus read 4 or 5 times in succession, the necessary data were obtained for computing the volume of sea-water, which in each individual case corresponded to 1^{cc} solution of silver.

In this manner, were compared on the one hand the freshly drawn samples of sea-water, and on the other, from time to time, also the standard samples, with the solution of silver, care being taken to keep the samples of water and the solution as near as possible at the same temperature. In order to prevent any portion of the fluid from adhering to the burettes, they were frequently rinsed with concentrated sulphuric acid.

With the figures obtained from these observations, the amount of chlorine in sea-water was afterwards determined by the following formula —

$$p = \frac{K S P}{k s}$$

in which p signifies the percentage of chlorine in the sample of water examined, k the proportion in cubic centimetres representing 1^{cc} of the solution of silver, and s the specific gravity of the water at 17°5 C.; P the mean between the amounts of chlorine found in the standard sample before the departure and after the return of the

vægt ved 17° 5 C. Disse Observationer bleve dog selv paa de to sidste Togter ikke anstillede i samme Udstrækning som Egenvægtsbestemmelserne, der ogsaa oprindelig vare bestemte til i første Række at tjene som Maal for den samlede Saltgehalt.

Expeditionen var for Egenvægtsbestemmelser forsynet med flere Sæt Glasaræometre fra Dr. Küchler i Ilmenau, indrettede til at vise Søvandets Egenvægt ved $\frac{17° 5}{17° 5}$[1], saaledes at et Sæt viste Egenvægter fra 1 til 1.007, et andet fra 1.006 til 1.013, et tredie fra 1.012 til 1.019, et fjerde fra 1.018 til 1.025 og et femte fra 1.024 til 1.031. Aræometrene vare inddelte i Delstreger af Værdi 0.0002, medens Afstanden mellem disse Delstreger paa Scalaen beløb sig til meget nær 1.5^{mm}, saaledes at man maatte kunne aflæse uden stor Feil det 5te Decimal. Under Aflæsningen af Vandprøvernes specifiske Vægt anbragtes disse i en i dobbelt Slingrebøile ophængt Glascylinder, hvis indre Diameter beløb sig til omtrent det tredobbelte af Aræometrets Corpus, hvorefter dette omhyggeligt renset og aftørret neddykkedes i Vædsken og tillodes at svømme frit i nogen Tid, indtil det havde antaget Vandets Temperatur. Aflæsningen foretoges nu langs den undre Rand af Vædskens Niveau, idet samtidig Vandets Temperatur iagttoges paa et controlleret Thermometer, inddelt i Delstreger af Værdi 0.° 2.

Paa Grund af det af Expeditionen benyttede Dampskibs fortrinlige Egenskaber som Søskib voldte disse Observationer i nogenlunde roligt Veir ingensomhelst Vanskeligheder, selv naar Kursen sattes ret mod Vinden, hvorimod Skibets Duvning i meget haardt Veir altid ytrede sig i mærkbare om end smaa Bevægelser hos Aræometret. Hvor Vandprøverne optoges i saa uroligt Veir, at Bestemmelsen paa Grund deraf kunde medføre forøget Usikkerhed, bleve de altid hensatte nogle Dage, indtil de kunde undersøges under mere gunstige Vilkaar.

Disse saaledes aflæste Egenvægter maa imidlertid i 2 Henseender forbedres, idet man paa den ene Side maa anvende passende Correctioner for at faa de ved meget forskjellige Temperaturer aflæste Egenvægter reducerede til den fælles Normaltemperatur 17.° 5, og paa den anden Side maa befrie dem for Aræometrenes constante Feil.

Hvad for det Første Correctionerne for Temperaturen angaar, da give de af flere Videnskabsmænd udførte Bestemmelser af Søvandets Volumforandring med Temperaturen Midlerne til at beregne disse, idet baade Hubbard[2], L. F.

[1] Naar her som ofte senere bruges Betegningsmaaden Egenvægt ved $\frac{t^0}{T^0}$, da menes dermed Egenvægt ved t^0 i Forhold til destilleret Vand af T^0 som Enhed. Alle Temperaturangivelser i denne Afhandling ere udtrykte i Grader Celsius.

[2] Maury's Sailing Directions 1858, — 1 — 237.

Expedition, K those amounts in cubic centimetres corresponding to 1^{cc} of the solution of silver, and S the specific gravity of the standard sample at 17° 5 C. These observations, however, were not instituted even on the two last voyages to the same extent as those based on determinations of specific gravity, the method by which, as originally agreed upon, the total amount of salt was to be chiefly computed.

For performing specific gravity determinations, the Expedition had been supplied by Dr. Küchler of Ilmenau with divers sets of glass areometers, adapted to show the specific gravity of sea-water at $\frac{17° 5}{17° 5}$[1], one set indicating specific gravities from 1 to 1.007, another from 1.006 to 1.013, a third from 1.012 to 1.019, a fourth from 1.018 to 1.025, and a fifth from 1.024 to 1.031. The areometers were graduated in degrees of 0.0002, the interspaces on the scale measuring however very nearly 1.5^{mm}; and hence you could read off with comparative accuracy to the fifth decimal. When about to read the specific gravity, the samples of water were poured into a glass cylinder suspended in gimbals, the inner diameter of the cylinder being triple that of the areometer, which, carefully wiped and dried, was immersed in the fluid and suffered to float freely for some time till of the same temperature as the water. The specific gravity was now read in the ordinary way, the temperature of the water, as shown by a tested thermometer graduated in fifths of a degree Centigrade, being simultaneously observed.

The steamer selected for the Expedition being an excellent sea-boat, these observations were attended with no difficulty whatever in moderately fair weather, even when steaming dead against the wind; pitching, however, was found to have a distinctly disturbing effect on the areometer, and therefore all samples of water drawn when it was in any way violent, so as to give reason for apprehending greater uncertainty in the determinations if performed at once, were stored for a few days, till the weather had improved.

These readings of specific gravity have, however, a twofold need of correction, arising on the one hand from the very different temperatures at which the specific gravities were read, involving the necessity of their reduction by proper corrections to the normal temperature 17° 5, and on the other, the constant error of the areometer, which has also to be eliminated.

As regards the corrections for temperature, these may be computed by the determinations performed by divers men of science of the extent to which the volume of sea-water varies with the temperature. Hubbard,[2] L. F.

[1] The expression, specific gravity at $\frac{t^0}{T^0}$, signifies specific gravity at t^0, with distilled water of T^0 as the unit of comparison. All statements of temperature in this Memoir are given in degrees Celsius.

[2] Maury's Sailing Directions, 1858, 1, p. 237.

Ekman[1] og Thorpe og Rücker[2] har givet meget fuldstændige Tabeller over Søvandets Volumina ved forskjellige Temperaturer, hvorhos tillige ogsaa Dr. Karsten[3] har opstillet en Correctionstabel, hvorefter man kan reducere de ved vilkaarlige Temperaturer aflæste Egenvægter til 17.°5. Sammenstiller man de Correctioner, som efter disse Iagttagelser kunne beregnes, erholder man imidlertid især for de lavere Temperaturer meget daarligt overensstemmende Værdier, idet der kan optræde Differenter, der endog kan overskride 0.0004, mellem de af Ekmann's og Hubbard's Observationer beregnede Correctioner, hersker der den største Overensstemmelse, men ogsaa her gaar Differentserne paa enkelte Puncter op til meget nær 0.0001. I Betragtning af disse tildels temmelig betydelige Uoverensstemmelser mellem de hidtil publicerede Undersøgelser af denne Art kunde det ikke findes ubeføiet endnu engang at gjenoptage Bestemmelserne af Søvandets Volumina ved forskjellige Temperaturer, og jeg besluttede mig derfor til gjennem egne Undersøgelser at forvisse mig om, hvilken af de opstillede Tabeller der bedst svarede til Udvidelsen af det i det norske Nordhav flydende Vand. Dels i dette Øjemed dels for at bestemme de benyttede Aræometres Correctioner og de Constanter, hvormed Chlorprocenterne og Decimalerne i Egenvægten maatte multipliceres for at give Saltmængden, har jeg anstillet Undersøgelser med følgende Vandprøver.

Station.	Bredde.	Længde fra Greenwich.	Dybde Eng. Fvn.	Dybde Meter.
245	68° 21′	2° 5′ V.	0	0
247	68 5.5	2 24 Ø.	500	941
253	Skjærstadfjord.		0	0
254	67° 27′	13° 25′	0	0
284	73 1	12 58	0	0
300	73 10	3 22 V.	0	0
349	76 30	2 57 Ø.	1487	2719
362	79 59	5 40	0	0

hvilke jeg for Kortheds Skyld i den Orden, hvori de her findes opførte, vil betegne med I, II o. s. v. indtil VIII. Til Bestemmelse af Søvandets Udvidelse benyttede jeg et Sprengel's Pyknometer[4], forarbeidet af to Stykker meget tynde Glasrør af et og samme Rør med en indvendig Diameter af omtrent 13^{mm}. Rørene vare nedentil sammenloddede ved Hjælp af et snævert kort u-formig bøiet Glasrør og oventil paaloddede knæformig bøiede solide Capillarrør med meget fin Aabning. Ved Paalodningen af disse Glasrør blev der saa meget som muligt draget Omsorg for, at kun en liden Del af de videre Rør udsattes for Opvarmning over Blæselampen, forat ikke Apparatet derved skulde

[1] Kongl. Svenska Vetenskapsak. Handlingar 1870 — 1.
[2] Proc. Roy. Soc., 24 — 159.
[3] Tafeln zur Berechnung der Beobachtungen an den Küstenstationen u. s. w. Kiel 1874.
[4] Pogg. Ann. 150 — 459.

Ekman[1], and Thorpe and Rücker[2] having prepared comprehensive Tables to show the volume of sea-water at different temperatures; Dr. Karsten[3], too, has published a Table of Corrections by which specific gravities read at any temperature may be reduced to 17.°5. Meanwhile, on comparing together the corrections computed from these observations, the values obtained, more especially for low temperatures, are found to agree but very indifferently, the difference in some cases exceeding even 0.0004. The agreement is closest between the corrections computed from Ekman's and Hubbard's observations; but here, too, the difference for some temperatures amounts to very nearly 0.0001. Considering, therefore, the want of uniformity, in some cases very considerable, exhibited by such observations of this kind as had till then been made public, it could not be deemed superfluous to investigate anew by a further series of experiments the variation in volume which sea-water is found to undergo at different temperatures; and hence I determined on ascertaining from the results of my own observations which of the aforesaid Tables corresponded best with the expansion of the water in the Norwegian Sea. Partly with this object in view, and partly in order to determine the corrections for the areometers and the constants by which the percentages of chlorine and the decimals of specific gravity had to be multiplied when computing the amount of salt, I examined the following samples of water: —

Station.	Latitude.	Longitude from Greenw.	Depth Eng. Fath.	Depth Metres.
245	68° 21′	2° 5′ W.	0	0
247	68 5.5	2 24 E.	500	941
253	The Skjærstad Fjord.		0	0
254	67° 27′	13° 25′	0	0
284	73 1	12 58	0	0
300	73 10	3 22 W.	0	0
349	76 30	2 57 E.	1487	2719
362	79 59	5 40	0	0

which I will indicate, for the sake of brevity, by the Roman numbers from I to VIII, and in the order in which they are given here. For determining the expansion of the sea-water, I made use of Sprengel's pycnometer;[4] the instrument was constructed of two pieces of glass tubing, cut off from the same length, with an inner diameter of about 13^{mm}. These tubes were sealed together at their lower ends by means of a short, narrow glass tube, bent into the form of the letter U, and had strong knee-shaped capillary tubes sealed on to their upper extremities. When sealing on these glass tubes, the greatest care was taken to confine the heat from the glass-blower's lamp to as small a portion

[1] Kongl. Svenska Vetenskapsak. Handlingar 1870. 1.
[2] Proc. Roy. Soc., 24, p. 159.
[3] Tafeln zur Berechnung der Beobachtungen an den Küstenstationen u. s. w. Kiel 1874.
[4] Pogg. Ann. 150, p. 459.

antage en anden Udvidelsescoefficient end den, det anvendte Glasrør oprindelig havde. Pyknometret blev først omkring 4 Maaneder, efterat det var blæst, taget i Brug til de Forsøg, som her skulle beskrives, forat ikke den for alle Glasgjenstande eiendommelige Contraction gjennem de første Maaneder efter deres Blæsning skulde bidrage til i mærkelig Grad at forandre dets Volum under Observationernes Udførelse. Pyknometret benyttedes ved de første Forsøg uden nogen Sikkerhedskugle, men maatte senere, hvor det fyldtes ved lavere Temperaturer, forsynes med en saadan, indrettet til at trækkes ind over det videre Capillarrør. Apparatet uden Sikkerhedskugle vil jeg for Kortheds Skyld betegne som Pyknometer No. 1 og med Sikkerhedskugle som Pyknometer No. 2. Ved Hjælp af disse udførtes følgende Forsøg i den Orden, hvori de her findes opførte.

	Pyknometer med Indhold.	Vægt Gr.	I Luft af sp. Vægt.
1.	Pykn. No. 1 tomt	15.9222	0.001200
2.	— - 1 „	15.9223	0.001200
3.	— - 1 med rent Vand af 17.°5	44.3153	0.001200
4.	— - 1 „ „ „ „ 17.5	44.3156	0.001201
5.	— - 1 „ „ „ „ 17.5	44.3151	0.001201
6.	— - 1 „ III . . . . „ 17.5	44.8097	0.001201
7.	— - 1 „ III . . . . „ 17.5	44.8093	0.001201
8.	— - 1 „ VII . . . . „ 17.5	45.0742	0.001200
9.	— - 1 „ VII . . . . „ 17.5	45.0738	0.001200
10.	— - 2 tomt	18.5665	0.001194
11.	— - 2 med I . . . . af 0.°	47.7869	0.001198
12.	— - 2 „ I . . . . „ 0.	47.7873	0.001198
13.	— - 2 „ I . . . . „ 0.	47.7871	0.001199
14.	— - 2 „ I . . . . „ 17.°5	47.7249	0.001201
15.	— - 2 „ I . . . . „ 17.5	47.7246	0.001201
16.	— - 2 „ I . . . . „ 20.	47.7085	0.001198
17.	— - 2 „ I . . . . „ 20.	47.7087	0.001198
18.	— - 2 „ I . . . . „ 8.	47.7696	0.001200
19.	— - 2 „ I . . . . „ 8.	47.7702	0.001200
20.	— - 2 „ I . . . . „ 4.	47.7810	0.001200
21.	— - 2 „ I . . . . „ 4.	47.7808	0.001200
22.	— - 2 „ I . . . . „ 13.	47.7487	0.001198
23.	— - 2 „ I . . . . „ 13.	47.7484	0.001198
24.	— - 2 med rent Vand „ 0.	46.9773	0.001191
25.	— - 2 „ „ „ „ 0.	46.9776	0.001191
26.	— - 2 tomt	18.5658	0.001191
27.	— - 1 „	15.9216	0.001191
28.	— - 2 „	18.5656	0.001231
29.	— - 1 „	15.9213	0.001231

Til Bestemmelse af Udvidelsescoefficienten af det anvendte Glas forarbeidedes af det samme Glasrør et andet engrenet Pyknometer nedentil tilsmeltet og oventil forsynet med et Capillarrør, idet der ogsaa her sørgedes for Opvarmning af en saa liden Del af Røret som muligt. Ved

as possible of the wider tubes, lest it should give to the apparatus a coefficient of expansion different to that which the glass tubes originally had. The pycnometer was not made use of for the experiments to be described here, till about 4 months after the tubes of which it consisted had been sealed together; for the contraction peculiar to all articles of glass throughout the first few months after they have been blown might otherwise have occasioned an appreciable change in its volume during the progress of the observations. For the first experiments, the pycnometer was used without a receiver, but subsequently, when filled at a lower temperature, one had to be provided, adapted so as to admit of its being drawn over the capillary tube. The apparatus when used *without* a receiver I shall designate for the sake of brevity 'Pycnometer No. 1,' and when used *with* a receiver, 'Pycnometer No. 2.' By means of this instrument the following experiments were performed, in the order in which they are here arranged.

	Pycnometer with Contents.	Weight in Grammes.	In Air with a Sp. Gr. of
1.	Pycn. No. 1 empty	15.9222	0.001200
2.	— - 1 „	15.9223	0.001200
3.	— - 1 with pure water of 17.°5	44.3153	0.001200
4.	— - 1 „ „ „ „ 17.5	44.3156	0.001201
5.	— - 1 „ „ „ „ 17.5	44.3151	0.001201
6.	— - 1 „ III . . . . „ 17.5	44.8097	0.001201
7.	— - 1 „ III . . . . „ 17.5	44.8093	0.001201
8.	— - 1 „ VII . . . . „ 17.5	45.0742	0.001200
9.	— - 1 „ VII . . . . „ 17.5	45.0738	0.001200
10.	— - 2 empty	18.5665	0.001194
11.	— - 2 with I . . . . of 0.°	47.7869	0.001198
12.	— - 2 „ I . . . . „ 0.	47.7873	0.001198
13.	— - 2 „ I . . . . „ 0.	47.7871	0.001199
14.	— - 2 „ I . . . . „ 17.°5	47.7249	0.001201
15.	— - 2 „ I . . . . „ 17.5	47.7246	0.001201
16.	— - 2 „ I . . . . „ 20.	47.7085	0.001198
17.	— - 2 „ I . . . . „ 20.	47.7087	0.001198
18.	— - 2 „ I . . . . „ 8.	47.7696	0.001200
19.	— - 2 „ I . . . . „ 8.	47.7702	0.001200
20.	— - 2 „ I . . . . „ 4.	47.7810	0.001200
21.	— - 2 „ I . . . . „ 4.	47.7808	0.001200
22.	— - 2 „ I . . . . „ 13.	47.7487	0.001198
23.	— - 2 „ I . . . . „ 13.	47.7484	0.001198
24.	— - 2 with pure water „ 0.	46.9773	0.001191
25.	— - 2 „ „ „ „ 0.	46.9776	0.001191
26.	— - 2 empty	18.5658	0.001191
27.	— - 1 —	15.9216	0.001191
28.	— - 2 —	18.5656	0.001231
29.	— - 1 —	15.9213	0.001231

For determining the coefficient of expansion of the glass, a single-branched pycnometer was constructed, of the same length of glass tubing, with the lower opening sealed up and the upper extremity bearing a capillary tube, care being taken, as before, not to heat a greater part of the large tube than

Hjælp af dette Apparat, som ved et Stykke Kautschukror var forbundet med et lidet Reservoir, bestemt til Optagelse af den ved mulig Opvarmning udskudte Del af Indholdet, bestemtes nu Udvidelsescoefficienten af det anvendte Glasrør med renset Kviksølv, som nogen Tid for Forsogenes Udførelse under Udkogning paafyldtes Pyknometret. Med dette Apparat, som jeg vil betegne som Pyknometer No. 3, udførtes til den Ende følgende Veininger.

	Pyknometer med Indhold.	Vægt Gr.	I Luft af sp. Vægt.
30.	Pykn. No. 3 tomt	10.8654	0.001214
31.	— - 3 „	10.8653	0.001214
32.	— - 3 med Kviksølv af 0°	195.9265	0.001215
33.	— - 3 „ „ „ 0	195.9265	0.001215
34.	— - 3 „ „ „ 20	195.3588	0.001205
35.	— - 3 „ „ „ 20	195.3592	0.001205
36.	— - 3 „ „ „ 15	195.4993	0.001205
37.	— - 3 „ „ „ 0	195.9276	0.001205
38.	— - 3 tomt	10.8650	0.001203
39.	— - 3 med rent Vand af 4°	24.4621	0.001202
40.	— - 3 „ „ „ „ 4	24.4634	0.001190

Alle disse Veininger ere udførte efter Substitutionsmethoden ved Aflæsning af Svingninger paa en Vægt, hvis Følsomhed uden Belastning beløb sig til 1.4 Mgr. pr. Delstreg og for stigende Belastning temmelig jevnt aftog indtil 1.9 Mgr. ved 200 Gr. Belastning. Til disse saavel som alle finere Veininger, som jeg har foretaget i Anledning af disse Arbeider, benyttedes en Platinalodsats fra Deleuil i Paris, hvis Correctioner jeg i Forveien havde bestemt ved flere vel overensstemmende Veininger paa en af P. Bunge forarbeidet fortrinlig Vægt, hvis Følsomhed for de her omhandlede Belastninger beløb sig til omkring 0.14 Mgr. Ved Veiningerne iagttoges altid Temperatur og Barometerstand af Luften i Veieværelset, hvorimod dens Fugtighedsgrad i Mangel af Observation passende ansattes, en Mangel, der ikke har nogen mærkbar Indflydelse paa Forsøgenes Paalidelighed, da selv en saa grov Feil i Ansættelsen af Luftens relative Fugtighed som 25 % under de her omhandlede Forhold kun virker paa det endelige Resultat med en liden Feil i 6te Decimal. Efter disse Data er Luftens specifiske Vægt under Veiningerne paa vanlig Maade beregnet og opført i Tabellen. Pyknometret blev for hver særskilt opført Veining indstillet paany for Temperaturen 0° i finstødt Is og forøvrigt i Vandbad, hvis Temperatur under stadig Omrøring holdtes constant, ligesom det mindst en Gang for hver anden Veining tømtes og fyldtes igjen med det Søvand, hvis Volum skulde bestemmes. Ingen Indstilling toges for god, med mindre det lykkedes i mindst 15 Minutter at holde Temperaturen saa constant, at Thermometret ingensinde viste Variationer af 0.°1 eller derover. Til Brug ved Aflæsning af Vandbadets Temperatur tjente

absolutely unavoidable. With this apparatus, which was connected by a caoutschouc tube with a small receiver for collecting any portion of the contents that, in the event of the instrument becoming warmer might possibly be expelled, the coefficient of expansion of the glass tube was now determined by means of purified mercury, which, shortly before the commencement of the experiment, had, when boiling out the air, been introduced into the pycnometer. With this apparatus, which I will designate 'Pycnometer No. 3,' were performed the following determinations of weight: —

	Pycnometer with Contents.	Weight in Grammes.	In Air with a Sp. Gr. of
30.	Pycn. No. 3 empty	10.8654	0.001214
31.	— - 3 „	10.8653	0.001214
32.	— - 3 with mercury of 0°	195.9265	0.001215
33.	— - 3 „ „ „ 0	195.9265	0.001215
34.	— - 3 „ „ „ 20	195.3588	0.001205
35.	— - 3 „ „ „ 20	195.3592	0.001205
36.	— - 3 „ „ „ 15	195.4993	0.001205
37.	— - 3 „ „ „ 0	195.9276	0.001205
38.	— - 3 empty	10.8650	0.001203
39.	— - 3 with pure water „ 4°	24.4621	0.001202
40.	— - 3 „ „ „ „ 4	24.4634	0.001190

These weight-determinations were all performed according to the substitution method, by reading the oscillations of a balance, the sensibility of which, when not loaded, amounted to 1.4 mgr for every division of the scale, diminishing, on being loaded with successive weights, at a comparatively uniform rate down to 1.9 mgr, when loaded with 200 gr. For the above-mentioned as for all accurate weight-determinations involved in these labours, I made use of a set of platina weights procured from Deleuil in Paris, the corrections of which I had previous to starting on the Expedition computed from a series of closely agreeing determinations of weight performed with an excellent balance (made by P. Bunge), its sensibility when loaded to the extent here specified being nearly 0.14 mgr. When performing the weight-determinations, the temperature and the atmospheric pressure in the room were always observed, but the relative humidity not having been found by observation had to be roughly estimated, a source of inaccuracy which however can exert no appreciable influence on the trustworthiness of the experiments, seeing that an error of even 25 per cent in the computation of the relative humidity of the atmosphere would affect the final result only by occasioning a very small error in the 6th decimal. From these data, the specific gravity of the air during the process of weighing was computed in the usual manner, and entered in the Table. For each successive determination, the pycnometer was placed in finely crushed ice, to give it the temperature of 0°, and for every other required, in a water-bath, which by constant stirring was kept at an equable temperature; it was emptied,

et Thermometer, inddelt i Delstreger af Værdi 0.°2 med en Længde af 0.68^{mm}., hvis Correctioner bestemtes ved gjentagne Sammenligninger med det herværende meteorologiske Instituts Normalthermometer, som til det Brug velvillig blev mig laant af Institutets Bestyrer, Professor Dr. Mohn.

Af Observationerne 32 til 37 kan først Udvidelsen af det til Pyknometrene benyttede Glasrør beregnes, og man erholder, naar de af Wüllner[1] beregnede Værdier for Kviksølvets Udvidelse lægges til Grund, som Udtryk for Glassets midlere Udvidelsescoefficient mellem 0° og 15° 0,0000267 og mellem 0° og 20° 0,0000274. Man kan desuden ogsaa benytte Observationerne 3, 4 og 5 i Forbindelse med 24 og 25 til Beregning af Glassets Udvidelse og erholder, naar man anvender de af Hällström[2] og Rosetti[3] bestemte Værdier for Vandets Udvidelse, meget vel overensstemmende Tal, som i Middel fastsætte Glassets midlere Udvidelsescoefficient mellem 0° og 17.°5 til 0.0000275. Efterat man heraf har bestemt en passende Værdi for Glassets Udvidelse, hvorved naturligvis de med Kviksølv udførte Bestemmelser fortrinsvis maa komme i Betragtning, kan man nu skride til Udledelsen af de videre Resultater af Forsøgene. Man maa imidlertid her tage Hensyn til, at Observationerne 1, 2, 10, 26, 27, 28 og 29 tydeligt bevise, at Pyknometret under Forsøgene har tabt omkring 0.7 Mgr. i Vægt, hvad der rimeligvis skriver sig fra Opløsning af en Del af Glasset paa de ydre Vægge paa Grund af den stadige Omrøring i Badet. Den herved foraarsagede Usikkerhed kan dog betydelig reduceres, naar man beregner Pyknometrets Vægt til enhver Tid under Forudsætning af, at Vægttabet er proportionalt med Observationernes Antal, idet Usikkerheden da knapt nok vil influere paa 5te Decimal. Under denne Forudsætning har jeg senere beregnet følgende Resultater, idet jeg paa enkelte Steder har tilladt mig smaa Aproximationer, som imidlertid kun kan virke paa de endelige Værdier med en liden Feil i 6te Decimal.

Egenvægt ved $\frac{17.°5}{17.°5}$ af III 1.01739.
$\frac{17.°5}{17.°5}$ af VII 1.02669.
$\frac{17.°5}{17.°5}$ af I 1.02691.
$\frac{0°}{0°}$ af I 1.02845.

[1] Pogg. Ann. 153 — 440.
[2] Disse Værdier ere ogsaa af Ekman benyttede til Bestemmelse af Udvidelsen af det Dilatometer, som denne til sine Forsøg over Søvandets Udvidelse har anvendt.
[3] Ann. Chim. Phys. [4] — 17 — 372.

too, at least once for every other determination, and again filled with the sea-water the volume of which had to be found. These observations were in no case considered satisfactory unless the temperature of the water-bath had been kept comparatively uniform for at least 15 minutes, the greatest variation indicated by the thermometer during that interval never having exceeded 0.°1. For reading the temperature of the water-bath, a thermometer graduated in divisons of 0.°2, measuring each 0.68^{mm}, was made use of, the instrument having been previously corrected by frequent comparison with the standard thermometer of the Norwegian Meteorological Institute, which the Director, Professor H. Mohn, had kindly lent me for that purpose.

Nos. 32—37 are the first of the observations by which the expansion of the glass in the pycnometer may be computed; and, taking the values found by Wüllner[1] for the expansion of mercury as the basis of calculation, the mean coefficient of expansion of the glass between 0° and 15° will be 0.0000267, and between 0° and 20°, 0.0000274. Moreover, Nos. 3, 4, and 5, in conjunction with Nos. 24 and 25, will also serve for determining the expansion of the glass; and, adopting the values computed by Hallström[2] and Rosetti[3] for the expansion of water, very closely agreeing results will be obtained, the figures expressing the average mean coefficient of expansion of the glass between 0° and 17.°5 being 0.0000275. After a proportionate value of the expansion of the glass has been found, for computing which preference should be given to the determinations performed with mercury, we may proceed to deduce the further results of the experiments. Meanwhile, regard must be had to the fact, of which the observations 1, 2, 10, 26, 27, 28, and 29 afford conclusive proof, that the pycnometer had lost about 0.7^{mgr} in weight during the progress of the experiments, some portion of the outer surface of the glass having probably been dissolved, a result of the constant motion of the water surrounding the instrument when in the water-bath. The uncertainty this occasions may however be very considerably reduced by computing the weight of the pycnometer for every experiment on the assumption that the loss of weight is proportional to the number of observations; in that case it will hardly influence the 5th decimal. On the basis of this assumption, I subsequently computed the following results, introducing here and there slight approximations, which, however, can affect the final result only by occasioning a small error in the 6th decimal.

Specific Gravity at $\frac{17.°5}{17.°5}$ of III 1.01739.
$\frac{17.°5}{17.°5}$ of VII 1.02669.
$\frac{17.°5}{17.°5}$ of I 1.02691.
$\frac{0°}{0°}$ of I 1.02845.

[1] Pogg. Ann. 153, p. 440.
[2] These values were also adopted by Ekman for determining the expansion of the dilatometer which he used when investigating the expansion of sea-water.
[3] Ann. Chim. Phys. [4], 17, p. 372.

og som Control paa det benyttede Kviksølvs Renhed dettes Egenvægt ved $\frac{0^\circ}{4^\circ}$ til 13.5963 samt Søvandets Volumina ved forskjellige Temperaturer til

t°	0	4	8	13	17.5	20
V_t af I	1.000000	1.000308	1.000794	1.001654	1.002605	1.003227

Til Udjevning af den efter disse Observationer optrukne Curve har jeg benyttet de mindste Kvadraters Methode, idet jeg har sat Ligningen for Søvandets Volum ved t° under Formen

$$V_t = 1 + at + bt^2 + ct^3.$$

Betingelsesligningerne blive

$$\begin{aligned}
a + 4\ b + 16\ c &- 0.000077 = 0\\
a + 8\ b + 64\ c &- 0.00009925 = 0\\
a + 13\ b + 169\ c &- 0.00012723 = 0\\
a + 17.5b + 306.25c &- 0.000148857 = 0\\
a + 20\ b + 400\ c &- 0.00016135 = 0
\end{aligned}$$

hvoraf Systemerne

$$\begin{aligned}
5a + 62.5\ b + 955.25c &- 0.000613687 = 0\\
62.5a + 955.25b + 16132.37c &- 0.008588 = 0\\
955.25a + 16132.37b + 286702\ c &- 0.1392135 = 0
\end{aligned}$$

som ved Elimination giver

$$\begin{aligned}
a &= 0.0000527328\\
b &= 0.00000617375\\
c &= -0.000000037516
\end{aligned}$$

eller ved Afrunding

$$V_t = 1 + 0.000052733t + 0.0000061738t^2 - 0.00000003752t^3.$$

Efter denne Formel har jeg beregnet følgende Tabel, hvori Søvandets Volum findes opført for hver hel Grad ogsaa for Temperaturerne under 0°, uagtet Formelens Gyldighed for dette Strøg ikke er støttet ved nogen Observation.

t°	V_t	t°	V_t	t°	V_t
−4	0.99989	5	1.00041	14	1.00185
−3	0.99990	6	1.00053	15	1.00205
−2	0.99992	7	1.00066	16	1.00227
−1	0.99995	8	1.00080	17	1.00250
0	1.00000	9	1.00095	17.5	1.00261
1	1.00006	10	1.00111	18	1.00273
2	1.00013	11	1.00128	19	1.00297
3	1.00021	12	1.00146	20	1.00322
4	1.00031	13	1.00165		

and, as a test of purity, the specific gravity of the mercury at $\frac{0^\circ}{4^\circ}$ was found to be 13.5963, and the volume of sea-water at different temperatures —

t°	0	4	8	13	17.5	20
V_t of I	1.000000	1.000308	1.000794	1.001654	1.002605	1.003227

For smoothing the curve laid down from these observations, I adopted the method of the least squares, giving the equation for the volume of the sea-water at t° the form —

$$V_t = 1 + at + bt^2 + ct^3.$$

The conditional equations will be —

$$\begin{aligned}
a + 4\ b + 16\ c &- 0.000077 = 0\\
a + 8\ b + 64\ c &- 0.00009925 = 0\\
a + 13\ b + 169\ c &- 0.00012723 = 0\\
a + 17.5b + 306.25c &- 0.000148857 = 0\\
a + 20\ b + 400\ c &- 0.00016135 = 0
\end{aligned}$$

from which are deduced —

$$\begin{aligned}
5a + 62.5\ b + 955.25c &- 0.000613687 = 0\\
62.5a + 955.25b + 16132.37c &- 0.008588 = 0\\
955.25a + 16132.37b + 286702\ c &- 0.1392135 = 0
\end{aligned}$$

and these equations give by elimination —

$$\begin{aligned}
a &= 0.0000527328\\
b &= 0.00000617375\\
c &= -0.000000037516
\end{aligned}$$

or, rounded off,

$$V_t = 1 + 0.000052733t + 0.0000061738t^2 - 0.00000003752t^3.$$

By means of this formula I determined the results set forth in the following Table, which shows the volume of sea-water, computed for every degree, including temperatures below 0°, although the applicability of the formula to the latter has not been ascertained from observation.

t°	V_t	t°	V_t	t°	V_t
−4	0.99989	5	1.00041	14	1.00185
−3	0.99990	6	1.00053	15	1.00205
−2	0.99992	7	1.00066	16	1.00227
−1	0.99995	8	1.00080	17	1.00250
0	1.00000	9	1.00095	17.5	1.00261
1	1.00006	10	1.00111	18	1.00273
2	1.00013	11	1.00128	19	1.00297
3	1.00021	12	1.00146	20	1.00322
4	1.00031	13	1.00165		

Til Sammenligning hidsættes her de af Ekman fundne Værdier for Volumet af 4 Vandprøver A, B, C og D af respective Egenvægter ved $\frac{15^\circ}{15^\circ}$ 1.01603, 1.01982, 1.02306, og 1.02695.

t°	V_t af A	V_t af B	V_t af C	V_t af D
—5	1.000145	1.000061	0.999983	0.999902
—4	1.000087	1.000020	0.999959	0.999894
—3	1.000044	0.999994	0.999948	0.999904
—2	1.000015	0.999983	0.999953	0.999922
—1	1.000001	0.999985	0.999969	0.999955
0	1.000000	1.000000	1.000000	1.000000
1	1.000019	1.000035	1.000043	1.000062
2	1.000047	1.000083	1.000100	1.000136
3	1.000096	1.000142	1.000168	1.000220
4	1.000154	1.000213	1.000249	1.000315
5	1.000223	1.000296	1.000344	1.000421
6	1.000305	1.000390	1.000450	1.000537
7	1.000399	1.000495	1.000567	1.000664
8	1.000504	1.000612	1.000696	1.000801
9	1.000621	1.000739	1.000836	1.000948
10	1.000749	1.000877	1.000985	1.001104
11	1.000888	1.001026	1.001145	1.001272
12	1.001038	1.001185	1.001315	1.001449
13	1.001199	1.001354	1.001495	1.001635
14	1.001370	1.001533	1.001683	1.001831
15	1.001551	1.001719	1.001880	1.002038
16	1.001742	1.001925	1.002085	1.002250
17	1.001943	1.002134	1.002299	1.002473
18	1.002153	1.002353	1.002520	1.002705
19	1.002373	1.002582	1.002749	1.002946
20	1.002601	1.002819	1.002984	1.003195
21	1.002839	1.003002	1.003227	1.003453
22	1.003085	1.003321	1.003474	1.003719
23	1.003340	1.003588	1.003728	1.003993
24	1.003602	1.003861	1.003988	1.004275
25	1.003875	1.004144	1.004253	1.004565

For den af mig undersøgte Vandprøve I er efter de forhen beskrevne Observationer fundet Egenvægten 1.02691 ved $\frac{17.^\circ 5}{17.^\circ 5}$ eller 1.02707 reduceret til $\frac{15^\circ}{15^\circ}$, medens Ekman for Vandprøven D har fundet Egenvægten 1.02695 ved $\frac{15^\circ}{15^\circ}$, og det fremgaar saaledes, at Undersøgelserne for disse Vandprøvers Vedkommende meget godt kunne gjøres til Gjenstand for Sammenligning. En saadan Sammenligning viser let, at der paa alle Puncter selv for Temperaturerne under 0° existerer en tilfredsstillende Overensstemmelse, idet Differentserne i Regelen ikke overstige 0.00001 og for de høiere Temperaturer, hvor de antage sin største Værdi, kun gaa op til omtrent 0.000025, en Uoverensstemmelse, som, naar Hensyn tages til Forskjellen mellem Vandprøvernes Egenvægter, end yderligere kan reduceres. Med de ovenfor nævnte af andre Chemikere udførte Undersøgelser

For comparison with these figures, are annexed the values found by Ekman for the volume of 4 samples of sea-water, A, B, C, and D, their specific gravity at $\frac{15^\circ}{15^\circ}$ being respectively 1.01603, 1.01982, 1.02306, and 1.02695.

t°	V_t of A	V_t of B	V_t of C	V_t of D
—5	1.000145	1.000061	0.999983	0.999902
—4	1.000087	1.000020	0.999959	0.999894
—3	1.000044	0.999994	0.999948	0.999904
—2	1.000015	0.999983	0.999953	0.999922
—1	1.000001	0.999985	0.999969	0.999955
0	1.000000	1.000000	1.000000	1.000000
1	1.000019	1.000035	1.000043	1.000062
2	1.000047	1.000083	1.000100	1.000136
3	1.000096	1.000142	1.000168	1.000220
4	1.000154	1.000213	1.000249	1.000315
5	1.000223	1.000296	1.000344	1.000421
6	1.000305	1.000390	1.000450	1.000537
7	1.000399	1.000495	1.000567	1.000664
8	1.000504	1.000612	1.000696	1.000801
9	1.000621	1.000739	1.000836	1.000948
10	1.000749	1.000877	1.000985	1.001104
11	1.000888	1.001026	1.001145	1.001272
12	1.001038	1.001185	1.001315	1.001449
13	1.001199	1.001354	1.001495	1.001635
14	1.001370	1.001533	1.001683	1.001831
15	1.001551	1.001719	1.001880	1.002038
16	1.001742	1.001925	1.002085	1.002250
17	1.001943	1.002134	1.002299	1.002473
18	1.002153	1.002353	1.002520	1.002705
19	1.002373	1.002582	1.002749	1.002946
20	1.002601	1.002819	1.002984	1.003195
21	1.002839	1.003062	1.003227	1.003453
22	1.003085	1.003321	1.003474	1.003719
23	1.003340	1.003588	1.003728	1.003993
24	1.003602	1.003861	1.003988	1.004275
25	1.003875	1.004144	1.004253	1.004565

According to the observations previously described the specific gravity of sample I, was, at $\frac{17.^\circ 5}{17.^\circ 5}$, 1.02691, or, reduced to $\frac{15^\circ}{15^\circ}$, 1.02707, and Ekman found the specific gravity of sample D to be 1.02695 at $\frac{15^\circ}{15^\circ}$. Hence the results, so far at least as these samples are concerned, very well admit of being compared; satisfactory agreement exists even for temperatures below 0°, since the difference does not as a rule exceed 0.00001, and for the highest temperatures, at which it is greatest, it amounts to only 0.000025; nay, these figures may be still further reduced by taking into account the specific gravities of the samples. With the results of the above-mentioned observations instituted by other chemists, those here described agree but indifferently. According to the formula deduced by

stemme de her beskrevne Resultater kun maadeligt overens. Ifølge den af Wackerbarth efter Ekmans Observationer beregnede Formel er Temperaturen for Tæthedsmaximum hos Søvand af Egenvægt 1.02707 = — 4.°04, medens Ligningen $\frac{dV}{dt} = 0$ med de af mig fundne Coefficienter giver Temperaturen —4.°45.

Paa Grund af denne gjennemførte Overensstemmelse mellem Ekmans og mine Resultater, har jeg ikke fundet det fornødent at bestemme Udvidelsen af Vandprøver af lavere Egenvægt, men har uden videre anvendt Ekmans Observationer paa de faa Puncter, hvor jeg til Reduction af de paa den norske Nordhavsexpedition aflæste Egenvægter har havt Brug for dem. Ved Hjælp af de ovenfor opførte Værdier for Søvandets Volumina ved forskjellige Temperaturer kan man nu beregne de Correctioner, hvormed de ved vilkaarlige Temperaturer aflæste Egenvægter maa forbedres forat reduceres til $\frac{17.°5}{17.°5}$. Correctionerne, hvori ogsaa indgaar et Led, der afhænger af Aræometrenes Udvidelsescoefficient,[1] findes sammenstillede i nedenstaaende Tabel.

$t°$	Correction	$t°$	Correction
0	—0.00224	12	—0.00104
2	—0.00214	14	—0.00069
4	—0.00201	16	—0.00031
6	—0.00183	18	0.00011
8	—0.00161	20	0.00056
10	—0.00134		

Hvor den Temperatur, hvorved Aflæsningen foretages, ikke fjerner sig meget fra Normaltemperaturen 17.°5, kan disse Correctioner, der strengt taget kun gjælde for Søvand af Egenvægt omkring 1.027, ogsaa uden mærkelig Feil anvendes for Vandprøver af en derfra temmelig forskjellig Egenvægt. Hvor derimod den Temperatur, hvorved Aflæsningen foretages, ligger langt fra 17.°5, ere disse Correctioner kun gyldige for et meget begrændset Interval.

Efterat saaledes de aflæste Egenvægter ved Anbringelse af disse Correctioner ere reducerede til Normaltemperaturen, staar det endnu tilbage at befrie dem for de ved de benyttede Aræometre heftende constante Feil.

Til Aflæsning af saa godt som alle paa Expeditionen bestemte Egenvægter benyttedes kun 3 Aræometre, to paa første Togt og et paa de to sidste. Af de to først nævnte, der af Svendsen for Udreisen vare udvalgte af de øvrige, fordi de havde vist sig at stemme særdeles vel overens, er desværre det ene senere bleven knust, det andet er endnu i Behold og er sammen med det paa sidste Togt benyttede bleven corrigeret af mig.

[1] Som saadan benyttedes 0.000026.

A. Wackerbarth from Ekman's observations, the temperature for the maximum density of sea-water with a specific gravity of 1.02707 is —4.°04, whereas the equation $\frac{dV}{dt} = 0$ gives, with my coefficients, a temperature of —4.°45.

Relying, then, on the close agreement between Ekman's results and my own, I have not determined the expansion in samples of sea-water with a lower specific gravity, but have adopted Ekman's observations, for reducing, when needful, the specific gravities read on the Norwegian North-Atlantic Expedition. By means of the values, tabulated above, for the volume of sea-water at different temperatures, the corrections which serve to reduce specific gravities read at any given temperature to $\frac{17.°5}{17.°5}$ may be computed. These corrections, into which the coefficient of expansion of the areometer[1] enters as a factor, are given in the following Table.

$t°$	Corrections	$t°$	Corrections
0	—0.00224	12	—0.00104
2	—0.00214	14	—0.00069
4	—0.00201	16	—0.00031
6	—0.00183	18	0.00011
8	—0.00161	20	0.00056
10	—0.00134		

When the temperature is not far removed from the normal temperature, 17.°5, these corrections, which, strictly speaking, apply only to sea-water with a specific gravity of about 1.027, may, without involving any appreciable error in the result, be likewise adopted for samples of water whose specific gravity differs considerably from that expressed by the above formula; but when, on the other hand, the temperature at which the specific gravity is read and that of 17.°5 lie far apart, the interval for which these corrections will serve is but very limited.

After reducing by means of these corrections the specific gravities to the normal temperature, there still remains to eliminate the constant error of the areometer.

For reading almost all of the specific gravities determined on the Expedition, only 3 areometers were made use of, two on the first cruise and one on the two last. Of the two former, which, having been found to agree uncommonly well, Mr. Svendsen had selected previous to his departure, one was unfortunately afterwards broken; the other is still in perfect order, and was, together with that made use of on the last voyage, corrected by myself.

[1] That adopted was 0.000026.

Correctionernes Bestemmelse udførtes ved Hjælp af Vandprøverne I og VII, hvis Egenvægter tidligere ere bestemte til 1.02691 og 1.02669 ved $\frac{17.°5}{17.°5}$. For det paa første Togt anvendte Aræometer erholdtes saaledes gjennem 5 Aflæsninger i I Correctionen —0.00023 og gjennem 12 Aflæsninger i VII ligeledes —0.00023. Paa samme Maade bestemtes det andet Aræometers Correctioner ved 5 Aflæsninger i I til —0.00037 og ved 8 Aflæsninger i VII til —0.00038. Under disse Aflæsninger var Vædsken altid bragt til 17.°5 eller en meget nærliggende Temperatur, hvorfra Aflæsningerne efter de forhen gjengivne Correctioner reduceredes til Normaltemperaturen. Gjennem flere Rækker Aflæsninger i Vandprøven I ved forskjellige Temperaturer har jeg tillige forvisset mig om, at den ved Beregning af Correctionstabellen benyttede Udvidelsescoefficient for Aræometrene er passende valgt.

Hermed er givet de fornødne Data til Reduction af de paa den norske Nordhavsexpedition aflæste Egenvægter, og jeg gaar dernæst over til Bestemmelsen af Relationerne mellem Saltgehalten, Chlormængden og Egenvægten.

Til Bestemmelse af Saltmængden har, saavidt jeg ved, tidligere kun været benyttet den simpleste Methode, bestaaende i Afdampning af Vandet og Residuets Tørring ved en passende Temperatur, som af de forskjellige Chemikere er bleven valgt noget forskjelligt fra 150°—180°. Denne Methode har jeg imidlertid af flere Grunde fundet lidet tilfredsstillende, hvad man ogsaa paa Forhaand maatte vente. Efter Graham[1] og andre taber nemlig den svovlsure Magnesia, om hvis Tilstedeværelse i Søvandet der vel ikke kan reises Tvivl, først ved en Temperatur af over 200° sit sidste Molekyl Vand, medens man paa den anden Side allerede ved en Temperatur af betydeligt under 200° maa befrygte en delvis Decomposition af den i Saltene tilstedeværende Chlormagnesium. Efter de Forsøg, som jeg anstillede, viste det sig, at Saltene selv efterat være tørrede ca. 20 Timer i Luftbad ved en Temperatur fra 170°—180° endnu indeholdt ikke ubetydelige Mængder Vand (omkring 15 Mgr. pr. Gr. Salt), medens de tørrede ved lidt lavere Temperatur indeholdt noget mere. Samtidig undersøgtes ogsaa Saltene paa fri Magnesia, hvorved jeg i Strid med ældre Angivelser fandt, at de bestandig selv ved Tørring ved 160° til 170° indeholdt uventet store Qvantiteter, saaat der for hvert Gr. tørret Salt fandtes en Magnesiamængde tilstrækkelig til at neutralisere over 20 Mgr. HCl (ved Tørring ved 180° fandt jeg endog en enkelt Gang 40 Mgr.). Bestemmelsen af den frie Magnesia foretoges ved Saltenes Opløsning i en afmaalt Mængde titreret Svovlsyre og derpaa følgende Retitration med fortyndet Natronlud af bekjendt Styrke. Ved Anvendelse af Rosolsyre som Index erholdtes her en meget skarp Endereaction.

[1] Phil. Mag. J. 6 — 422.

The determination of the corrections was performed with the water of samples I and VII, whose specific gravity at $\frac{17.°5}{17.°5}$ had been found to be respectively 1.02691 and 1.02669. For the areometer used on the first voyage, 5 readings with the water of sample I gave the correction —0.00023, and 12 readings with the water of sample VII likewise —0.00023; in the same manner, the corrections for the other areometer were determined, by 5 readings with the water of sample I, to be —0.00037, and, by 8 readings with the water of sample VII, to be —0.00038. For these readings, the fluid was always brought to 17.°5, or as near that temperature as possible, the readings having in the latter case to be reduced, by means of the corrections given above, to the normal temperature. Several series of readings with the water of sample I, at different temperatures, convinced me that the coefficient of expansion for the areometer which I had computed for preparing the Table of Corrections was practically correct.

Having now specified the data necessary for reducing the specific gravities read on the Norwegian North-Atlantic Expedition, I shall proceed to determine the relation between the specific gravity of sea-water and the amount of salt and chlorine it contains.

For determining the amount of salt, the only method formerly resorted to was, so far as I am aware, the simplest, viz. that of evaporating the water and then drying the residue at a proper temperature, which has been variously fixed by different chemists at from 150° to 180°. This method, however, has proved in several respects defective, as was indeed to be expected. According to Graham[1] and others, sulphate of magnesia, the presence of which in sea-water can hardly admit of doubt, does not part with its last molecule of water till exposed to a temperature of more than 200° whereas, on the other hand, it is highly probable that partial decomposition of the chloride of magnesium contained in the salt takes place considerably below 200°. Even after the salts had been dried for about 20 hours in an air-bath at a temperature of 170°—180°, they were still found to contain, according to my experiments, a considerable quantity of water (about 15^{mgr} salt per gramme); dried at a lower temperature, the amount was somewhat greater. I also tested the salts for free magnesia, and found, in direct opposition to earlier statements, that, even when dried at 160°—170°, they invariably contained a very large amount, the quantity of magnesia to every gramme of dried salt being sufficient to neutralize more than 20^{mgr} HCl (once, when dried at 180°, even 40^{mgr}). For determining the free magnesia, the salts were dissolved in a given quantity of titrated sulphuric acid, and the fluid then retitrated with dilute soda-lye of known strength. With rosolic acid as the index, the final reaction was very decided.

[1] Phil. Mag. J. 6, p. 422.

Forat undgaa de her omtalte Feil, benyttedes til Bestemmelse af Saltmængden i Søvandet følgende Fremgangsmaade.

I en med tætsluttende Laag forsynet tyk, veiet Porcellaindigel indveiedes 30 til 40 Gr. Søvand, som afdunstedes paa Vandbad. Efterat Saltene vare nogenlunde vel tørrede, ophededes Digelen med Laaget paa ca. 5 Minutter over en Bunsens Lampe, afkjøledes og veiedes paany. Derefter bestemtes paa den forud beskrevne Maade den ved Decomposition af Chlormagnesium dannede frie Magnesia, hvorved de til Beregning af den samlede Saltgehalt fornødne Data erholdtes.

I en tidligere Afhandling[1] har jeg paavist, at Carbonaterne i Søvandet ved Kogning omsætter sig til kulsur Magnesia, som ved Inddampning eller under enhver Omstændighed ved Glødning efterlader Magnesia, og man skulde altsaa strengt taget for den saaledes dannede Del af den frie Magnesia beregne en anden Correction end for den ved Decomposition af Chlormagnesium dannede Hovedmængde. Den Feil, man begaar, ved at undlade dette, er imidlertid baade meget nær constant og desuden saa liden, at den uden videre kan negligeres, idet den kun bidrager til at formindske den samlede Saltgehalt med omkring 0.0015 %. Det er saaledes fuldstændig tilstrækkeligt til den ved Veiningen fundne Mængde tørret Salt at addere 1.375 Gange den ved Titreringen bestemte Mængde fri Magnesia, for af det saaledes fremkomne Tal at beregne Saltgehalten i Procenter.

Mod denne Methode kan der dog reises Indvendinger, idet det kunde befrygtes, at mindre Qvantiteter Chlornatrium, Chlormagnesium eller Chlorkalium under Glødningen kunde fortlygtiges, eller at en Del af den svovlsure Magnesia ved den høie Temperatur kunde decomponeres og give Anledning til Tab af Svovlsyre. Man kan imidlertid let forvisse sig om, at dette ved Anvendelse af en tyk Porcellaindigel med tætsluttende Laag ikke bevirker nogen Feil af mærkbar Indflydelse. Saaledes fandt jeg, at 1.2 Gr. af en passende Blanding af Chlorkalium og Chlornatrium ved $1^1/_4$ Times stærkest mulig Glødning over en Bunsens Lampe i den samme Digel, som jeg benyttede til mine Saltbestemmelser, kun tabte 2 Mgr. i Vægt, det vil sige, Blandingen tabte ved Glødningen ikke fuldt 0.14 Mgr. pr. 5 Minutter. Ligeledes paavistes ved Bestemmelse af Svovlsyre og Magnesia saavel i det benyttede Søvand som i det glødede Residuum, at man selv ved en meget længere fortsat Glødning end den, der udfordres forat skaffe fuldstændig vandfrit Salt, ikke risikerer nogen skadelig Feil foranlediget ved Forflygtigelse af Chlormagnesium eller Decomposition af svovlsur Magnesia.

[1] "Om Kulsyren i Søvandet" Side 40 øverst.

In order to guard against the above-mentioned errors, the following mode of operation was adopted for determining the amount of salt in sea-water.

From 30^{gr} to 40^{gr} of sea-water were introduced into a thick porcelain crucible of known weight, furnished with a tight-fittting cover, and evaporated on a water-bath. So soon as the salt was sufficiently dry, the crucible, with the cover on, was heated for about 5 minutes over one of Bunsen's gas-burners, then cooled and weighed with its contents. The free magnesia liberated by the decomposition of the chloride of magnesium was now determined in the manner previously described, and the last factor necessary for computing the total amount of salt accordingly found.

In a former paper[1] I drew attention to the fact, that the carbonates present in sea-water are transformed during the process of boiling into carbonate of magnesia, which after evaporation, or, at least, on the salt being thoroughly heated, leaves a residue of magnesia; and hence the proportion of free magnesia thus formed would, strictly speaking, seem to involve the need of a correction different from that adopted for the principal amount liberated by the decomposition of the chloride of magnesium. But the error which arises from applying the same correction to both is, on the one hand, very nearly constant, and, on the other, so small as to admit of being safely ignored, seeing that it reduces the total amount of salt only about 0.0015 per cent. It is, therefore, amply sufficient, if to the amount of dried salt found by weighing be added 1.375 times the amount of the free magnesia determined by titration: the figure thus obtained will serve to compute the percentage of salt.

This method certainly is so far open to objection, that small quantities of chloride of sodium, chloride of magnesium, or chloride of potassium may be volatilized during the process of heating, or some portion of the sulphate of magnesia be decomposed at the high temperature, and thus occasion a loss of sulphuric acid. The error, however, arising from this source will not exert any appreciable influence on the result, provided the crucible used for the operation be of thick porcelain, and have a tight-fitting cover. Thus, for instance, I found that 1.2^{gr} of a proportionate mixture of chloride of potassium and chloride of sodium, on being heated for the space of an hour and a quarter over one of Bunsen's gas-burners in the crucible I had used for my salt-determinations, lost only 2^{mgr} in weight, or 0.14^{mgr} every 5 minutes. Moreover, it was manifest on determining the sulphuric acid and magnesia both in the water itself and in the heated residue, that, even in the event of the heating-process being much more protracted than is necessary to obtain salt free from the smallest trace of water, no serious error can result from the volatilization of chloride of magnesium or the decomposition of sulphate of magnesia.

[1] "On the Carbonic Acid in Sea-Water," p. 40.

At Methoden giver indbyrdes vel overensstemmende Resultater, viser de talrige Saltbestemmelser, som udførtes med samme Vandprøver. Saaledes fandtes ved nedenstaaende Forsøg

Proc. Salt i II {3.525, 3.517 — Proc. Salt i VII {3.514, 3.516, 3.515

— — - III {2.303, 2.299

— — - IV {3.386, 3.385

— — - V {3.530, 3.533

— — - VI {3.276, 3.279

— — - VIII {3.501, 3.507, 3.508, 3.500, 3.502, 3.506, 3.500, 3.501

Resultaterne ere, som man ser, allerede her temmelig vel overensstemmende, men kunde visselig gives en endnu større Nøiagtighed, om man vilde arbeide med noget større Quantiteter Søvand.

For Vandprøverne III og VII er Egenvægten ved $\frac{17.^{\circ}5}{17.^{\circ}5}$ allerede tidligere ved Hjælp af Pyknometer bestemt til respective 1.01739 og 1.02669, for Vandprøverne IV, V, VI og VIII er den funden ved gjentagne Aflæsninger paa et af de corrigerede Aræometre, medens den for Prøven II kun blev bestemt ved en enkelt Aflæsning. Ligeledes bestemtes meget omhyggeligt samtlige Vandprøvers Chlormængder. Heraf kan

$$\text{Chlorcoefficienten} = \frac{\text{Saltmængden}}{\text{Chlormængden}}$$

og

$$\text{Egenvægtscoefficienten} = \frac{\text{Saltmængden}}{\text{Egenvægten} - 1}$$

beregnes, saaledes som det er gjort i nedenstaaende Tabel.

No.	Egenvægt ved $\frac{17.^{\circ}5}{17.^{\circ}5}$	Chlormængde %	Saltmængde %	Egenvægtscoefficient.	Chlorcoefficient.
II	1.02670	1.947	3.521	131.9	1.808
III	1.01739	1.271	2.301	132.3	1.810
IV	1.02573	1.868	3.386	131.6	1.813
V	1.02676	1.956	3.532	132.0	1.806
VI	1.02488	1.809	3.278	131.8	1.812
VII	1.02669	1.947	3.515	131.7	1.805
VIII	1.02655	1.938	3.503	131.9	1.808

Som det heraf fremgaar, er baade Chlor- og Egenvægtscoefficienterne tiltrods for Saltgehalternes Forskjellighed overalt meget nær constante, saa at Variationerne

That the results obtained by this method must be regarded as agreeing very closely *inter se*, is shown by the numerous salt-determinations performed with the same samples of water.

Per cent. of Salt in II {3.525, 3.517 — Per cent. of Salt in VII {3.514, 3.516, 3.515

„ „ - — - III {2.303, 2.299

„ „ - - IV {3.386, 3.385

„ „ - — - V {3.530, 3.533

„ „ - - VI {3.276, 3.279

„ „ - — - VIII {3.501, 3.507, 3.508, 3.500, 3.502, 3.506, 3.500, 3.501

These figures, it will be seen, differ but little *inter se*, and by increasing the quantity of water greater accuracy could no doubt be attained.

For samples III and VII, the specific gravity at $\frac{17.^{\circ}5}{17.^{\circ}5}$, respectively 1.01739 and 1.02669, had been previously determined by means of the pycnometer; for samples IV, V, VI, and VIII, it was found by repeated readings of one of the corrected areometers, whereas for sample II it was determined by one reading only. The amount of chlorine, too, in each sample was carefully determined. From these data may be computed the

$$\text{Coefficient of Chlorine} = \frac{\text{Amount of Salt}}{\text{Amount of Chlorine}}$$

and the

$$\text{Coefficient of Specific Gravity} = \frac{\text{Amount of Salt}}{\text{Specific Gravity} - 1}$$

as set forth in the following Table.

No.	Spec. Grav. at $\frac{17.^{\circ}5}{17.^{\circ}5}$	Percentage of Chlorine.	Percentage of Salt.	Coefficient of Spec.Grav.	Coefficient of Chlorine.
II	1.02670	1.947	3.521	131.9	1.808
III	1.01739	1.271	2.301	132.3	1.810
IV	1.02573	1.868	3.386	131.6	1.813
V	1.02676	1.956	3.532	132.0	1.806
VI	1.02488	1.809	3.278	131.8	1.812
VII	1.02669	1.947	3.515	131.7	1.805
VIII	1.02655	1.938	3.503	131.9	1.808

It thus appears, that the coefficients both of chlorine and specific gravity, notwithstanding the difference in the percentage of salt, are always very nearly constant;

rimeligst bliver at tilskrive Observationsfeil. Som Chlorcoefficient kan heraf opstilles

$$1.809 \pm 0.00076$$

med en sandsynlig Feil af en enkelt Bestemmelse af $\pm$ 0.002 og som Egenvægtscoefficient

$$131.9 \pm 0.058$$

med en sandsynlig Feil af en enkelt Bestemmelse af $\pm$ 0.15.

Disse Værdier stemme især for Chlorcoefficientens Vedkommende ganske vel overens med tidligere fundne Værdier, saaledes har baade Forchhammer og Ekman i Middel fundet 1.811, medens de af Andre opstillede Egenvægtscoefficienter overalt ere noget mindre end den af mig fundne.

Ved Hjælp af disse Coefficienter har jeg af de paa Expeditionens Togter udførte Chlor- og Egenvægtsbestemmelser beregnet Vandprøvernes Saltgehalt og sammen med Originalobservationerne opført dem i nedenstaaende Tabel.

Egenvægterne ere i Regelen kun aflæste med 4 Decimaler, det 5te er kun opført, hvor det havde en Værdi nær 5, saa at det kunde være Tvivl underkastet, om der ved Afrunding skulde formindskes eller forhøies. I de reducerede Egenvægter findes ligeledes kun opført 4 Decimaler, hvor det uden Tvivl kunde afgjøres, til hvilken Side Afrundingen skulde finde Sted, hvorimod der i modsat Fald ogsaa der er tilføiet et 5te. De med * betegnede Egenvægter ere aflæste paa Aræometre, hvis Correction ikke er bleven bestemt. Til Optagelse af de til Undersøgelse af Saltholdigheden bestemte Vandprøver er foruden det tidligere beskrevne, af Wille construerede, Apparat ogsaa paa grundere Vand ofte benyttet den af Ekman angivne fortrinlige Vandhenter, som imidlertid ifølge den Fremgangsmaade, hvorefter Dyblodninger paa den norske Expedition foretoges, ikke egnede sig til Brug ved større Dyb.

Ved Velvillie af Professor Mohn har jeg faaet opgivet de undersøgte Vandprøvers Temperatur i Havet, hvorved det er bleven muligt ogsaa at tilføie en Rubrik for deres Egenvægter ved denne Temperatur i Forhold til rent Vand af 4°.[1] Af de i Tabellen gjengivne Observationer ere alle indtil No. 149 udførte paa 1ste Togt af Svendsen, alle fra 149 til 225 paa 2det Togt af mig, de øvrige ere udførte paa sidste Togt af Schmelck og mig i Fællesskab, saaledes at det største Antal skyldes Schmelck, der dette Aar medfulgte Expeditionen.

[1] Rent Vand af 4° er ved denne Reduction valgt som Enhed, fordi den allerede tidligere er anvendt af J. Y. Buchanan (Proc. Roy. Soc. 24—597). Ved Beregning af Egenvægternes Værdi ved Havets Temperatur i Forhold til Vand af 4° er Forholdet mellem Volumet af rent Vand ved 4° og 17.°5 sat — 0.99768.

and hence the variation in the results should most probably be ascribed to errors of observation. The coefficient of chlorine may accordingly be taken at —

$$1.809 \pm 0.00076$$

with a probable error in a single determination of $\pm$ 0.002, and the coefficient of specific gravity, at —

$$131.9 \pm 0.058$$

with a probable error in a single determination of $\pm$ 0.15.

These values agree closely, in particular as regards the coefficient of chlorine, with those previously found. Thus, for instance, the mean value found both by Forchhammer and Ekman was 1.811, whereas the coefficient of specific gravity given by former observers is somewhat lower than mine.

By means of these coefficients I have computed from the determinations of chlorine and specific gravity the amount of salt in the samples of water collected on the Expedition, and have set down the observations and their results in the accompanying Table, which calls for a brief explanation.

The specific gravities are as a rule not read to more than 4 decimals, a fifth being added only in the event of its having a value of 5, in which case it is often doubtful whether, when rounding off the figures, there should be increase or diminishment. The reduced specific gravities, too, are expresed with 4 decimals only, wherever it was manifest in which direction the rounding off had to be made; when such is not the case, a fifth has been added. An asterisk at the side of a specific gravity denotes that the latter was determined with an areometer for which no correction had been found. Besides the instrument devised by Wille, of which a description has been given, Ekman's excellent apparatus was likewise made use of, in comparatively shallow localities, for collecting the samples of sea-water in which to determine the amount of salt; the mode of sounding practised on the Norwegian North-Atlantic Expedition would not admit of its adoption for greater depths.

Professor Mohn has kindly furnished me with the temperatures of the samples of water *in situ*, which has enabled me to give an aditional column for the specific gravities at those temperatures as compared with pure water of 4°.[1] Of the observations given in the Table, those extending from No. 1 to No. 149 were performed on the first voyage, by Mr. Svendsen; those extending from No. 149 to No. 225, on the second voyage, by myself; the remainder were taken on the last voyage, by Mr. Schmelck and myself conjointly, the greater number, however, by Mr. Schmelck, who that year accompanied the Expedition.

[1] Pure water of 4° was chosen as the unit of reduction, J. Y. Buchanan having previously adopted it as such (Proc. of Roy. Soc. 24, p. 597). When computing the specific gravities at the temperature of the sea, as compared with water of 4°, the ratio existing between the volume of pure water at 4° and 17.°5 was assumed to be 0.99768.

Tab. III.

No.	Stat. No.	Nordlig Bredde. (North Latitude.)	Længde fra Greenwich. (Longitude from Greenwich.)	Dybde hvorfra Proven hentet. (Depth from which the Samples were collected.) Engelske Favne. (English Fathoms.)	Meter. (Metres.)	Aflæste Egenvægter. (Specific Gravity read.)	Temperatur. (Temperature.) Under Aflæsningen. (When read.)	I Havet. (In Situ.) t^0	Egenvægter. (Specific Gravity.) Ved 17.°5 / 17.°5 (At 17.°5 / 17.°5)	Ved t^0 / 4° (At t^0 / 4°)	Chlormængde. (Amount of Chlorine.)	Saltmængde. (Amount of Salt measured.) Efter Aræometer. (By the Areometer.)	Efter Chlormængde. (By the Amount of Chlorine.)
1	—	Esefjord, Sogn.		0	0	1.0151*	14.8	—	1.01465	—	—	1.93	—
2	—	Do.		1	2	1.0234*	13.7	—	1.0227	—	—	2.99	—
3	—	Do.		2	4	1.0237*	12.5	—	1.0228	—	—	3.01	—
4	—	Do.		3	5	1.0241*	13.0	—	1.0233	—	—	3.07	—
5	—	Do.		4	7	1.0242*	13 8	—	1.0235	—	—	3.19	—
6	—	Do.		5	9	1.0240*	17.3	—	1.02395	—	—	3.16	—
7	—	Do.		6	11	1.0245*	17.0	—	1.0244	—	—	3.22	—
8	—	Do.		7	13	1.0249*	20.0	—	1.02545	—	—	3.36	—
9	2	61° 9.′6	6° 31.′9	672	1229	1.0270	16.7	6.7	1.0266	1.0274	—	3.51	—
10	—	Fjærland.		0	0	1.0118*	9.2	—	1.0107	—	—	1.41	—
11	—	Esefjord.		0	0	1.0147*	12.0	—	1.0139	—	—	1.46	—
12	—	Do.		1	2	1.0188*	12.5	—	1.0180	—	—	2.37	—
13	3	61° 5.′2•5°	15.′3 E.	618	1130	1.0280	11.0	6.6	1.0266	1.0274	—	3.51	—
14	—	Husø.		0	0	1.0262	9.7	—	1.0246	—	—	3.24	—
15	—	Do.		0	0	1.0262	9.9	—	1.02465	—	—	3.25	—
16	—	Do.		0	0	1.0262	10.2	—	1.0247	—	—	3.26	—
17	—	Do.		6	11	1.0261	10.7	—	1.02465	—	—	3.25	—
18	—	Do.		6	11	1.0258	15.6	—	1.0252	—	—	3.32	—
19	—	Do.		0	0	1.0262	10.9	—	1.0248	—	—	3.27	—
20	—	61° 25′	3° 41′ E.	0	0	1.0254	16.8	—	1.0250	—	—	3.30	—
21	10	61 41.1	3 18.5	0	0	1.0253	16.2	11.5	1.0248	1.0248	—	3.27	—
22	12	61 53.3	3 0	0	0	1 0270	18.0	11.1	1.0269	1.0270	—	3.55	—
23	14	62 4	2 44.5	0	0	1.0265	19.9	9.9	1.0268	1.0271	—	3.53	—
24	14	62 4	2 44.5	226	413	1.0268	18.6	6.1	1.0268	1.0277	—	3.53	—
25	16	62 23.9	2 17	0	0	1.0275	15.4	10.9	1.02685	1.0270	—	3.54	—
26	17	62 33	2 4	0	0	1.0271	17.5	11.2	1.0269	1.0269	—	3.55	—
27	18	62 44.5	1 48	0	0	1.0270	18.4	11.6	1.0270	1.02695	—	3.56	—
28	—	62 39	2 8	0	0	1.0270	17.9	12.5	1.0269	1.0267	—	3.55	—
29	—	62 29	2 34	0	0	1.0273	16.2	12.5	1.0268	1.0266	—	3.53	—
30	19	62 23.5	2 50	0	0	1.0262	17.5	11.0	1.0260	1.02605	—	3.43	—
31	20	62 16.3	3 8	0	0	1.0256	18.7	11.2	1.0256	1.0257	—	3.38	—
32	21	62 14.7	3 27.5	0	0	1.0251	17.8	13.4	1.02495	1.02455	—	3.29	—
33	22	62 13.2	3 40.5	0	0	1.0254	18.0	12.6	1.0253	1.02505	—	3.34	—
34	—	62 52.5	5 51.5	0	0	1.0252	19.5	12.1	1.0254	1.0253	—	3.35	—
35	—	62 56	6 16	0	0	1.0253	18.4	12.8	1.0253	1.0250	—	3 34	—
36	—	Christiansund.		0	0	1.0255	17.5	—	1.0253	—	—	3.34	—
37	—	63° 10′	6° 30′	0	0	1.0260	16.2	10.0	1.0255	1.0257	—	3.36	—
38	24	63 10	5 57.5	0	0	1.0262	17.5	11.7	1.0260	1.0259	—	3.43	—
39	24	63 10	5 57.5	90	165	1.0262	17.5	6.9	1.0260	1.0267	—	3.43	—
40	—	63 10	5 19	0	0	1.0266	17.2	11.2	1.0263	1.0264	—	3.47	—
41	26	63 10	5 16	0	0	1.0261	17.6	11.8	1.0259	1.0258	—	3.41	—
42	—	63 7.1	5 17	0	0	1.0264	18.6	11.7	1.0264	1.0264	—	3.48	—
43	—	63 10	4 56	0	0	1.0264	17.5	11.6	1.0262	1.0261	—	3.46	—
44	32	63 10	4 51.3	430	786	1.0270	17.0	—0.6	1.0267	1.0281	—	3.52	—
45	—	63 9	3 56	0	0	1.0265	16.2	11.2	1.0260	1.0260	—	3.43	—
46	—	63 6	3 1	0	0	1.0260	15.8	11.8	1.0254	1.02535	—	3.35	—
47	33	63 5	3 0	525	960	1.0279	15.0	—1.1	1.0272	1.0286	—	3.59	—
48	—	63 5	2 57	0	0	1.0271	15.2	11.6	1.0264	1.0264	—	3.48	—
49	—	63 4	2 52	0	0	1.0269	14.6	12.3	1.0261	1.0259	—	3.44	—
50	—	63 3	2 43	0	0	1.0266	17.3	11.9	1.0263	1.0262	—	3.47	—
51	—	63 3	2 10	0	0	1.0275	14.3	12.0	1.02665	1.0265	—	3.52	—
52	—	63 5	1 7	0	0	1.0278	14.7	11.5	1.0270	1.0270	—	3.56	—
53	34	63 5	0 52.5	587	1073	1.0277	15.0	—1.0	1.0270	1.0284	—	3.56	—
54	—	63 3	0 54	0	0	1.0277	14.8	12.0	1.02695	1.0268	—	3.55	—
55	—	62 48	1 51	0	0	1.0273	16.3	11.9	1.0268	1.0267	—	3.53	—
56	—	62 44	2 10	0	0	1.0272	16.1	11.4	1.0267	1.0267	—	3.52	—

No.	Stat. No.	Nordlig Bredde. (North Latitude.)	Længde fra Greenwich. (Longitude from Greenwich.)	Dybde hvorfra Prøven hentet. (Depth from which the Samples were collected.) Engelske Favne. (English Fathoms.)	Meter. (Metres.)	Aflæste Egenvægter. (Specific Gravity read.)	Temperatur. (Temperature.) Under Aflæsningen. (When read.)	I Havet. (In Situ) t^{0}	Egenvægter. (Specific Gravity.) Ved $\frac{17.^{0}5}{17.^{0}5}$ (At $\frac{17^{0}5}{17^{0}5}$)	Ved $\frac{t^{0}}{4^{0}}$ (At $\frac{t^{0}}{4^{0}}$)	Chlormængde. (Amount of Chlorine.)	Saltmængde. (Amount of Salt measured.) Efter Areometer. (By the Areometer.)	Efter Chlormængde. (By the Amount of Chlorine.)
57	—	62° 37′	2° 37′ E.	0	0	1.0277	13.1	11.5	1.0266	1.0266	—	3.51	—
58	—	62 40.5	1 58	0	0	1.0276	13.7	11.4	1.0266	1.02665	—	3.51	—
59	—	62 45	1 13	0	0	1.0277	14.6	11.4	1.0269	1.0269	—	3.55	—
60	—	63 2	1 12 W.	0	0	1.0275	15.9	11.1	1.02695	1.0270	—	3.55	—
61	—	63 3	1 14	0	0	1.0275	13.4	10.8	1.0265	1.0266	—	3.50	—
62	—	63 4	1 19	0	0	1.0277	13.2	10.8	1.02665	1.1268	—	3.52	—
63	—	63 6	1 24	0	0	1.0279	12.5	10.4	1.0267	1.0269	—	3.52	—
64	—	63 8	1 26	0	0	1.0279	12.9	10.8	1.0268	1.0269	—	3.53	—
65	—	63 12	1 26	0	0	1.0279	12.8	10.4	1.0268	1.0270	—	3.53	—
66	—	63 14	1 27	0	0	1.0278	12.8	10.5	1.0267	1.02685	—	3.52	—
67	—	63 17	1 28	0	0	1.0279	13.3	10.8	1.02685	1.0270	—	3.54	—
68	—	63 18	1 23	0	0	1.0280	11.9	10.8	1.0267	1.02685	—	3.52	—
69	—	63 45	0 57	0	0	1.0277	15.2	10.7	1.0270	1.0272	—	3.56	—
70	—	63 46	1 0	0	0	1.0277	15.2	10.2	1.0270	1.02725	—	3.56	—
71	–	63 26	1 28	0	0	1.0274	16 5	10.8	1.02695	1.0271	–	3.55	
72	—	63 18	1 38	0	0	1.0275	16.2	10.4	1.0270	1.0272	—	3.56	—
73	—	63 8	1 58	0	0	1.0279	13.8	10.4	1.02695	1.02715	—	3.55	—
74	—	62 58	2 8	0	0	1.0279	14.0	10.2	1.0270	1.0272	—	3.56	—
75	–	62 46	3 34	0	0	1.0277	14.0	9.8	1.0268	1.0271	—	3.53	—
76	—	62 34	4 28	0	0	1.0283	11.9	9.4	1.0270	1.0274	—	3.56	–
77	—	62 20	5 28	0	0	1.0282	12.3	10.0	1.0270	1.02725	—	3.56	—
78	—	62 5	6 22	0	0	1.0278	13.8	10.6	1.02685	1.0270	—	3.54	—
79	—	Thorshavn.		0	0	1.0280	13.4	9.4?	1.0270	1.02735	—	3.56	—
80[1]	—	Do.		0	0	1.0266	10.2	9.4	1.0251	1.0254	—	3.31	—
81	—	Do.		0	0	1.0275	15.8	9.4	1.0269	1.0273	—	3.55	—
82	—	Naalsø Nordpynt (Northern Extremity of Naalsø.)		0	0	1.0276	15.0	9.4	1.0269	1.02725	—	3.55	—
83	—	Do.		0	0	1.0277	15.0	9.4	1.0270	1.02735	—	3.56	—
84	37	62° 28′.3	2° 29′ W.	309	565	1.0276	15.3	0.1	1.0269	1.0283	—	3.55	—
85	37	62 28.3	2 29	690	1262	1.0276	15.8	—1.1	1.0270	1.0285	—	3.56	—
86	—	62 15	4 32	0	0	1.0274	15.8	9.3	1.0268	1.0272	—	3.53	—
87	—	62 23	3 26	0	0	1.0274	15.5	9.6	1.0268	1.0271	—	3.53	—
88	—	62 28	2 29	0	0	1.0274	15.7	10.4	1.0268	1.0270	—	3.53	—
89	—	62 37	2 52	0	0	1.0275	15.7	10.2	1.0269	1.0271	—	3.55	—
90	—	62 50	3 30	0	0	1.0276	15.3	10.5	1.0269	1.0271	–	3.55	—
91	—	62 57	3 47	0	0	1.0275	14.8	10.3	1.02675	1.0270	–	3.53	—
92	—	63 12	4 39	0	0	1.0274	15.7	9.7	1.0268	1.0271	—	3.53	—
93	—	63 22	5 20	0	0	1.0277	14.0	9.4	1.0268	1.0272	—	3.53	—
94	40	63 22.5	5 29	515	942	1.0277	13.6	—0.4	1.0267	1.0281	—	3.52	—
95	40	63 22.5	5 29	0	0	1.0277	13.8	9.7	1.02675	1.0271	—	3.53	—
96	40	63 22.5	5 29	0	0	1.0277	13.8	9.7	1.02675	1.0271	–	3.53	—
97	40	63 22.5	5 29	0	0	1.0277	15.4	10.3	1.02705	1.0273	—	3.57	—
98	—	Reikjavik.		0	0	1.0272	11.1	9.8	1.0258	1.0261	—	3.40	
99	—	Midten af Faxebugt (The Middle of Faxe Bay.)		0	0	1.0267	16.3	10.0?	1.0262	1.0265	—	3.46	—
100	—	63° 49′	22° 52′	0	0	1.0273	14.5	8.8	1.0265	1.0269		3.50	—
101	—	63 37	21 58	0	0	1.0274	14.2	9.7	1.0265	1.0268	—	3.50	—
102	—	63 42	22 25	0	0	1.0278	11.7	9.5	1.0265	1.0268		3.50	—
103	—	63 25	21 0	0	0	1.0271	15.6	10.0	1.0265	1.02675	–	3.50	—
104	—	63 13	19 54	0	0	1.0273	15.6	10.4	1.0267	1.0269	—	3.52	—
105	—	63 6	18 43	0	0	1.0273	16.8	10.6	1.0269	1.0271	—	3.55	–
106	—	63 7	17 31	0	0	1.0273	15.3	10.2	1.0266	1.02685	—	3.51	—
107	—	63 7	16 20	0	0	1.0273	15.6	11.0	1.0267	1.0268		3.52	—
108	–	63 8	15 9	0	0	1.0276	15.2	11.0	1.0269	1.0270	—	3.55	—
109	—	63 8	13 59	0	0	1.0279	13.0	10.7	1.0268	1.02695	—	3.53	—
110	–	63 20	13 22	0	0	1.0272	16.0	10.7	1.02665	1.0268	—	3.52	—
111	45	63 28	12 58	0	0	1.0273	16.9	10.4	1.02695	1.02715		3.55	—
112	—	63 38	12 35	0	0	1.0270	13.6	10.0	1.0269	1.0272	—	3.55	—

[1] Stærk Regn. (Heavy Rain.)

No.	Stat. No.	Nordlig Bredde. (*North Latitude.*)	Længde fra Greenwich. (*Longitude from Greenwich.*)	Dybde hvorfra Proven hentet. (*Depth from which the Samples were collected.*) Engelske Favne. (*English Fathoms.*)	Meter. (*Metres.*)	Aflæste Egenvægter. (*Specific Gravity read.*)	Temperatur. (*Temperature.*) Under Aflæsningen. (*When read.*)	I Havet. (*In Situ*) t^0	Egenvægter. (*Specific Gravity.*) Ved $\frac{17.^0 5}{17.^0 5}$ (*At* $\frac{17^0 5}{17^0 5}$)	Ved $\frac{t^0}{4^0}$ (*At* $\frac{t^0}{4^0}$)	Chlormængde. (*Amount of Chlorine.*)	Saltmængde. (*Amount of Salt measured.*) Efter Aræometer. (*By the Areometer.*)	Efter Chlormængde. (*By the Amount of Chlorine.*)
113	—	63° 57′	11° 52′ W.	0	0	1.0277	13.6	10.2	1.0267	1.0269	—	3.52	—
114	—	64 14	11 12	0	0	1.0277	14.0	9.5	1.0268	1.0271	—	3.53	—
115	48	64 36	10 21.5	0	0	1.0279	11.5	5 3	1.02655	1.0275	—	3.50	—
116	—	64 44	10 4	0	0	1.0270	17 5	7.0	1.0268	1.0275	—	3.53	—
117	—	65 0	9 24	0	0	1.0269	18.0	7.4	1.0268	1.0275	—	3.53	—
118	—	65 21	8 36	0	0	1.0271	16.8	7.8	1.0267	1.0273	—	3.52	—
119	—	65 39	7 53	0	0	1.0271	15.0	7.2	1.0264	1.02705	—	3.48	—
120	51	65 53	7 18	0	0	1.0272	15.0	8.0	1.0265	1.02705	—	3.50	—
121	51	65 53	7 18	515	942	1.0272	16.0	—0.6	1.02665	1.0281	—	3.52	—
122	51	65 53	7 18	1163	2127	1.0272	16.0	—1.1	1.02665	1.0281	—	3.52	—
123	—	65 51	5 36	0	0	1.0269	18.2	8.4	1.0268	1.02735	—	3.53	—
124	—	65 49	4 18	0	0	1.0270	17.6	9.3	1.0268	1.0272	—	3.53	—
125	52	65 47.5	3 7	0	0	1.0270	17.6	9.7	1.0268	1.0271	—	3.53	—
126	52	65 47.5	3 7	515	942	1.0270	17.4	—0.4	1.02675	1.0282	—	3.53	—
127	52	65 47.5	3 7	1861	3403	1.0280	12.0	—1.2	1.0267	1.0282	—	3.52	—
128	—	64 47	4 24 E.	0	0	1.0274	13.9	11.0	1.02645	1.02655	—	3.49	—
129	—	64 47	4 24	0	0	1.0264	19.5	11.0	1.0266	1.0267	—	3.51	—
130	—	64 49	4 46	0	0	1.0263	19.0	10.8	1.0264	1.0265	—	3.48	—
131	—	64 46	5 38	0	0	1.0270	18.0	11.2	1.0269	1.02695	—	3.55	—
132	—	64 42	6 47	0	0	1.0265	19.0	10.6	1.0266	1.0268	—	3.51	—
133	—	64 37	8 0	0	0	1.0265	19.0	10.8	1.0266	1.0267	—	3.51	—
134	—	64 27	8 36	0	0	1.0253	19.2	10.5	1.02545	1.0256	—	3.36	—
135	—	Mellem Sydhund og Revillen. Between Sydhund and Revillen.		0	0	1.0220*	15.8	—	1.0217	—	—	2.86	—
136	63	64° 41.3	9° 0′	0	0	1.0278	13.4	11.6	1.0268	1.02675	—	3.53	—
137	68	64 44.1	8 9	0	0	1.0277	13.0	11.6	1.0266	1.0266	—	3.51	—
138	73	64 46.5	7 28	0	0	1.0276	13.0	11.3	1.0265	1.0265	—	3.50	—
139	—	64 48	6 45	0	0	1.0277	13.0	11.5	1.0266	1.0266	—	3.51	—
140	—	64 48	6 26	0	0	1.0281	12.2	11.6	1.02685	1.0268	—	3.54	—
141	—	64 33	5 31	0	0	1.0278	14.2	11.8	1.0269	1.0269	—	3.55	—
142	—	64 4	5 35	0	0	1.0277	13.8	11.7	1.02675	1.0267	—	3.53	—
143	—	64 2	5 42	0	0	1.0277	13.8	12.0	1.02675	1.0267	—	3.53	—
144	89	64 1	6 7.5	0	0	1.0277	13.8	12.2	1.02675	1.0266	—	3.53	—
145	—	64 0	6 42	0	0	1.0279	12.0	11.4	1.0266	1.02665	—	3.51	—
146	—	63 48	6 42	0	0	1.0268	12.8	12.8	1.0257	1.0264	—	3.39	—
147	—	63 22	6 47	0	0	1.0259	12.8	—	1.0248	—	—	3.27	—
148	—	Stadt.		0	0	1.0250	14.2	—	1.02415	—	—	3.19	—
149	94	59° 8.2	4° 38′	0	0	1.0259	12.0	9.8	1.0245	1.0248	—	3.23	—
150	94	59 8.2	4 38	145	265	1.0263	12.0	5.0	1.0249	1.0258	—	3.28	—
151	95	60 42.5	4 13.7	0	0	1.0254	12.9	9.4	1.0242	1.0245	—	3.18	—
152	95	60 42.5	4 13.7	175	320	1.0278	11.9	5.8	1.0264	1.0272	—	3.48	—
153	—	64 47	2 50	0	0	1.0276	12.7	9.4	1.0263	1.0267	—	3.47	—
154	96	66 8.5	3 0	0	0	1.0278	13.5	8.2	1.0266	1.0272	—	3.51	—
155	96	66 8.5	3 0	805	1472	1.0275	14.9	—1.1	1.0266	1.0280	—	3.51	—
156	97	66 2	4 21	683	1249	1.0284	10.9	—1.1	1.0268	1.0283	—	3.53	—
157	98	65 56	5 21	388	710	1.0278	13.0	—1.0	1.02655	1.0280	—	3.50	—
158	99	65 51.5	6 25	213	390	1.0277	13.5	6.1	1.0265	1.0274	—	3.50	—
159	101	65 36	8 32	0	0	1.0276	12.6	9.4	1.0263	1.02665	—	3.47	—
160	101	65 36	8 32	223	408	1.0283	10.3	6.0	1.0266	1.0275	—	3.51	—
161	104	65 28	9 56	162	296	1.0282	11.4	6.5	1.0267	1.0275	—	3.52	—
162	124	66 41	6 59	0	0	1.02735	14.5	8.4	1.0264	1.0269	—	3.48	
163	125	67 52.5	5 12	0	0	1.0282	10.1	7.0	1.0265	1.0272	1.957	3.50	3.54
164	125	67 52.5	5 12	700	1280	1.0280	10.4	—1.1	1.02635	1.0278	1.951	3.48	3.53
165	137	67 24	8 58	0	0	1.02745	9.9	8.2	1.0257	1.0263	—	3.39	—
166	137	67 24	8 58	400	732	1.0281	11.7	—1.0	1.0266	1.0281	—	3.51	—
167	143	66 58	10 33	0	0	1.0273	10.7	8.2	1.0257	1.0262	1.899	3.39	3.44
168	143	66 58	10 33	189	346	1.0279	12.0	6.2	1.0265	1.0273	1.956	3.50	3.54

No.	Stat. No.	Nordlig Bredde. (North Latitude.)	Længde fra Greenwich. (Longitude from Greenwich.)	Dybde hvorfra Proven hentet. (Depth from which the Samples were collected.) Engelske Favne. (English Fathoms.)	Meter. (Metres.)	Aflæste Egenvægter. (Specific Gravity read.)	Temperatur. (Temperature.) Under Aflæsningen. (When read.)	I Havet. (In Situ) t°	Egenvægter. (Specific Gravity.) Ved $\frac{17.^{\circ}5}{17.^{\circ}5}$ (At $\frac{17^{\circ}5}{17^{\circ}5}$)	Ved $\frac{t^{\circ}}{4^{\circ}}$ (At $\frac{t^{\circ}}{4^{\circ}}$)	Chlormængde. (Amount of Chlorine.)	Saltmængde. (Amount of Salt measured.) Efter Aræometer. (By the Areometer.)	Efter Chlormængde. (By the Amount of Chlorine.)
169		Hopen ved Bodø. (Hopen near Bodø.)		0	0	1.0091*	11.7	—	1.0083	—	—	1.09	—
170	152	67° 18′	12° 46′ E.	0	0	1.0266	14.3	8.2	1.0256	1.0261	—	3.38	
171	152	67 18	12 46	70	128	1.0270	13.5	4.1	1.02585	1.0269	—	3.41	—
172	152	67 18	12 46	125	229	1.0274	13.5	4.1	1.0262	1.0273	—	3.46	—
173	162	68 23	10 20	795	1454	1.0270	17.2	−1.2	1.0266	1.0280	1.943	3.51	3.51
174	—	Indløbet til Hasseltjord. (Entrance to the Hassel Fjord.)		0	0	1.0269	14.5	8.8	1.0259	1.0264	—	3.41	—
175	171	69° 18′	14° 29′	0	0	1.0272	11.9	9.0	1.0258	1.0262	—	3.40	—
176	171	69 18	14 29	642	1174	1.0282	9.9	—1.0	1.0265	1.0279	—	3.50	—
177	176	69 18	14 32.7	0	0	1.0270	13.3	8.0	1.0258	1.0264	—	3.40	—
178	179	69 32	11 10	0	0	1.0280	10.9	8.8	1.0264	1.0269	1.945	3.48	3.52
179	179	69 32	11 10	1607	2939	1.0282	9.7	—1.2	1.0264	1.0279	1.935	3.48	3.50
180	183	69 59.5	6 15	0	0	1.0279	13.3	8.6	1.0267	1.0272	1.952	3.52	3.53
181	184	70 4	9 50	0	0	1.0280	12.6	7.6	1.0267	1.0273	1.943	3.52	3.51
182	184	70 4	9 50	600	1097	1.0279	12.8	0.0	1.0266	1.0280	1.928	3.51	3.49
183	184	70 4	9 50	1547	2829	1.02765	13.4	—1.3	1.0265	1.0279	1.935	3.50	3.50
184	187	69 51.5	14 41	1335	2441	1.0276	15.2	—1.1	1.02675	1.0282	1.933	3.53	3.50
185	188	69 43	15 29	0	0	1.0278	13.2	9.0	1.0266	1.0270	1.939	3.51	3.51
186	189	69 41	15 42	0	0	1.0275	13.2	9.6	1.0263	1.0266	1.923	3.47	3.48
187	189	69 41	15 42	860	1573	1.0279	12.9	—1.1	1.0266	1.0281	1.931	3.51	3.49
188	200	71 25	15 40.5	0	0	1.0282	9.9	7.8	1.0265	1.0271	—	3.50	—
189	200	71 25	15 40.5	620	1134	1.0285	9.4	—1.0	1.0267	1.0281	1.949	3.52	3.53
190	206	70 45	14 36	0	0	1.0282	9.5	8.2	1.0264	1.0270	1.945	3.48	3.52
191	206	70 45	14 36	700	1280	1.0285	8.7	—0.7	1.0266	1.0280	1.945	3.51	3.52
192	206	70 45	14 36	1248	2282	1.0283	9.2	—1.1	1.0265	1.0279	1.945	3.50	3.52
193	—	Indløbet til Malangenfjord. (Entrance to the Malangen Fjord.		0	0	—	—	—	—	—	1.744	—	3.15
194	212	70° 12.5	17° 41′	0	0	1.0255	21.7	7.2	1.0261	1.02675	1.895	3.44	3.43
195	212	70 12.5	17 41	142	260	1.0272	17.6	5.8	1.02685	1.02775	1.940	3.54	3.51
196	213	70 23	2 30	0	0	1.0277	14.2	8.2	1.0267	1.0272	1.956	3.52	3.54
197	213	70 23	2 30	1760	3219	1.0274	15.5	—1.2	1.0266	1.02805	1.951	3.51	3.53
198	215	70 53	2 0 W.	0	0	1.0276	14.9	8.0	1.0267	2.0273	1.945	3.52	3.52
199	215	70 53	2 0	200	366	1.02755	15.2	2.8	1.0267	1.0279	1.945	3.52	3.52
200	215	70 53	2 0	700	1280	1.0276	14.3	—0.6	1.0266	1.0280	1.935	3.51	3.50
201	215	70 53	2 0	1665	3045	1.0275	14.5	—1.2	1.0265	1.02795	1.939	3.50	3.51
202	217	71 0	5 8.5	0	0	1.0283	6.5	4.6	1.0262	1.0272	—	3.46	—
203	—	Østpynten af Jan Mayen. (Eastern Extremity of Jan Mayen.)		0	0	1.0280	4.0	3.0	1.02565	1.0268	—	3.38	—
204	225	70° 58′	8° 4′	0	0	1.0278	9.2	3.4	1.0260	1.0271	—	3.43	—
205	226	70 59	7 51	0	0	1.0277	10.5	3.0	1.0261	1.0272	1.893	3.44	3.42
206	226	70 59	7 51	340	622	1.0282	9.1	—0.6	1.02635	1.0278	1.936	3.48	3.50
207		69 20	11 18	0	0	1.0276	12.8	4.3	1.0263	1.02745	1.925	3.47	3.48
208	—	68 33	7 25	0	0	—	—	6.0	—	—	1.936	—	3.50
209	243	68 32.5	6 26	0	0	1.0280	12.8	7.8	1.0267	1.0273	1.945	3.52	3.52
210	243	68 32.5	6 26	600	1097	1.02715	16.7	—0.8	1.0266	1.0280	1.927	3.51	3.49
211	243	68 32.5	6 26	1385	2533	1.0286	5.7	—1.3	1.0264	1.0278	1.940	3.48	3.51
212	245	68 21	2 5	0	0	1.0280	13.4	9.0	1.0268	1.02725	—	4.53	—
213	247	68 5.5	2 24 E.	0	0	1.0278	13.8	9.4	1.0267	1.0271	1.954	3.52	3.53
214	247	68 5.5	2 24	500	914	1.0278	13.1	−0.4	1.0266	1.0280	1.927	3.51	3.49
215	247	68 5.5	2 24	1120	2048	1.0275	14.5	−1.2	1.0265	1.02795	1.929	3.50	3.49
216	249	68 12	6 35	1063	1944	1.0274	15.4	—1.3	1.0266	1.0280	1.937	3.51	3.50
217	251	68 6.5	9 44	0	0	1.0276	13.9	13.2	1.0265	1.0262	1.927	3.50	3.49
218	252	Søndenfor Skraaven. (South of Skraaven.)		0	0	1.0254	19.2	14.0?	1.0254	1.0249	1.820	3.35	3.29
219	253	Skjærstadfjord.		0	0	1.0178*	14.4	13.0	1.0173	1.0168	1.261	2.28	2.28
220	253	Do.		263	481	1.02755	11.2	3.2	1.0260	1.02715	1.887	3.43	3.41
221	254	67° 27′	13° 25′	0	0	1.0266	12.6	10.0	1.0253	1.0255	1.843	3.34	3.33
222	254	67 27	13 25	70	128	1.0278	11.2	4.8	1.02625	1.0272	1.929	3.46	3.49
223	254	67 27	13 25	140	256	1.0281	12.1	5.8	1.0267	1.0276	1.931	3.52	3.49
224	—	Frohavet.		0	0	1.0262	12.0	—	1.0248	—	1.822	3.27	3.29

No.	Stat. No.	Nordlig Bredde. (North Latitude.)	Længde fra Greenwich. (Longitude from Greenwich.)	Dybde hvorfra Proven hentet. (Depth from which the Samples were collected.) Engelske Favne. (English Fathoms.)	Meter. (Metres.)	Aflæste Egenvægter. (Specific Gravity read.)	Temperatur. (Temperature.) Under Aflæsningen. (When read.)	I Havet. (In Situ) t°	Egenvægter. (Specific Gravity.) Ved 17.°5/17.°5 (At 17°.5/17°.5)	Ved t°/4° (At t°/4°)	Chlormængde. (Amount of Chlorine.)	Saltmængde. (Amount of Salt measured.) Efter Areometer. (By the Areometer.)	Efter Chlormængde. (By the Amount of Chlorine.)
225	255	68° 12.'3	15° 40' E.	0	0	1.0262	14.3	10.7	1.0252	1.0253	—	3.32	—
226	255	68 12.3	15 40	300	549	1.0280	12.9	6.5	1.0267	1.0275	—	3.52	—
227	256	70 8.5	23 4	0	0	—	—	—	—	—	1.118	—	2.02
228	256	70 8.5	23 4	225	411	1.0280	10.9	4.0	1.0264	1.0275	1.930	3.48	3.49
229	258	70 12.6	23 2.5	0	0	1.0276	8.3	11.6	1.0257	1.0256	1.865	3.39	3.37
230	258	70 12.6	23 2.5	230	421	1.0282	6.9	4.0	1 0261	1.0272	1.907	3.44	3.45
231	259	70 48.9	25 59	80	146	1.0286	6.7	4.1	1.02645	1.0275	1.942	3.49	3.51
232	261	70 47.5	28 30	0	0	1.0248	11.9	7.4	1.0234	1.0240	1.713	3.09	3.10
233	261	70 47.5	28 30	127	232	1.0280	10.9	2.8	1.0264	1.0276	1.920	3.48	3.47
234	262	70 36	32 35	0	0	1.0282	8.5	5.6	1.0263	1.0272	1.921	3.47	3.47
235	262	70 36	32 35	148	271	1.0284	8.9	1.9	1.0265	1.0278	1.932	3.50	3.49
236	263	70 44.5	34 14	121	221	1.1286	6.9	1.9	1.0265	1.02775	1.927	3.50	3.49
237	264	70 56	35 37	0	0	1.0279	11.3	5.2	1.0264	1.0273	1.929	3.48	3.49
238	264	70 56	35 37	86	157	1.0281	11.4	1.9	1.0266	1.02785	1.934	3.51	3.50
239	268	71 36.5	36 18	0	0	1.0284	8.7	4.4	1.0265	1.02755	1.925	3.50	2.48
240	268	71 36.5	36 18	130	238	1.0285	8.9	—1.0	1.0266	1.0281	1.938	3.51	1.51
241	270	72 27.5	35 1	0	0	1.0284	9.0	3.6	1.02655	1.0277	1.937	3.50	1.50
242	270	72 27.5	35 1	136	249	1.0286	8.9	0 0	1.0267	1.0281	1.937	3.52	3.50
243	272	73 10.8	33 3	113	207	1.0285	8 9	1.5	1.0266	1.0279	1.937	3.51	3.50
244	273	73 25	31 30	0	0	1.0285	8.7	4.9	1.0266	1.0276	1.938	3.51	3.51
245	273	73 25	31 30	197	360	1.0285	8.5	2.2	1.0266	1.0278	1.943	3.51	3.51
246	275	74 8	31 12	0	0	1.0287	5.9	2.9	1.0265	1.0277	1.935	3.50	3.50
247	275	74 8	31 12	147	269	1.0289	5.5	—0.4	1.02665	1.02805	1.936	3.52	3 50
248	278	74 1.5	22 27	0	0	1.0286	5.9	4.2	1.0264	1.02745	—	3.48	—
249	278	74 1.5	22 27	230	421	1.0287	5.3	0.9	1.0264	1.0278	—	3.48	—
250	280	74 10.5	18 51	0	0	1.0282	9.3	1.2	1.0264	1.0277	—	3.48	—
251	280	74 10.5	18 51	35	64	1.0283	9.4	1.1	1.0265	1.0278	—	3.50	
252	281	74 3	17 18	0	0	1.0285	8.9	4.6	1.0266	1.02765	1.967	3.51	3.56
253	281	74 3	17 18	115	210	1.0287	8.8	2.2	1.0268	1.0281	1.939	3.53	3.51
254	283	73 47.5	14 21	0	0	1.0282	11.3	7.2	1.0267	1.0274	1.938	3.52	3.51
255	284	73 1	12 58	0	0	1.0283	11.2	6.8	1.02675	1.0275	1.940	3.53	3.51
256	286	72 57	14 32	447	817	1.0284	9.5	—0.8	1.0266	1.02805	—	3.51	—
257	289	72 41.5	20 18	0	0	1.0282	11.1	7.6	1.02665	1.0273	—	3.52	—
258	289	72 41.5	20 18	219	400	1.0282	11.1	2.0	1.02665	1.0279	—	3.52	—
259	291	71 54	21 57	0	0	1.0280	12.0	7.4	1.0266	1.02725	1.936	3.51	3.50
260	291	71 54	21 57	194	355	1.0284	10.5	3.0	1.02675	1.02795	1.944	3.53	3.52
261	293	71 7	21 11	0	0	1.0272	5.0	—	1.02495	—	1.909?	3.29	3.45
262	293	71 7	21 11	95	174	1.0276	5.3	—	1.0254	—	1.943	3.35	3.51
263	294	71 35	15 11	0	0	1.0272	4 9	—	1.02495	—	1.918	3.29	3.47
264	294	71 35	15 11	637	1165	1.0284	7.1	—1.2	1.0263	1.02775	1.934	3.47	3.50
265	295	71 59	11 40	0	0	1.0278	13.5	7.0	1.02665	1.02735	1.942	3.52	3.51
266	295	71 55	11 30	100	183	1.0283	10.1	3.2	1.0266	1.0278	1.942	3.51	3.51
267	295	71 55	11 30	600	1097	1.0281	10.7	—0.8	1.0265	1.0279	1.936	3.50	3.50
268	295	71 59	11 40	1110	2030	1.0278	13.3	—1.3	1.0266	1.02805	1.934	3.51	3.50
269	296	72 15.5	8 9	100	183	1.0286	7.1	3.1	1.0265	1.0277	1.944	3.50	3.52
270	296	72 15.5	8 9	600	1097	1.0287	7.1	—0.5	1.0266	1.0280	1.939	3.51	3.51
271	297	72 36.5	5 12	0	0	1.0284	5.9	4.8	1.0262	1.0272	1.928	3.46	3 49
272	297	72 36.5	5 12	1280	2341	1.0286	5.0	—1.4	1.0263	1.02775	1.926	3.47	3.48
273	298	72 52	1 50.5	0	0	1.0272	15.1	4.0	1.0263	1.0274	1.917	3.47	3.47
274	298	72 52	1 50.5	1500	2743	1.0271	16.8	—1.5	1.0266	1.0280	1.915?	3.51	—
275	299	73 10	2 14 W.	0	0	1.0269	13.7	3.6	1.0258	1.0269	1.888	3.40	3.42
276	300	73 10	3 22	0	0	1.0255	15.2	1.7	1.0247	1.0259	1.810	3.26	3.27
277	301	74 1	1 20	0	0	1.0263	14.3	2.2	1.0253	1.0265	1.837	3.34	3.32
278	302	75 16	0 54	0	0	1.0285	7.9	3.0	1.0265	1.0277	1.920	3.50	3.47
279	303	75 12	3 2 E.	0	0	1.0283	6.5	3.3	1.02615	1.0273	1.914	3.45	3.46
280	303	75 12	3 2	150	274	1.0288	4.4	—1.1	1.02645	1.0279	1.929	3.49	3.49

No.	Stat. No.	Nordlig Bredde. (*North Latitude.*)	Længde fra Greenwich. (*Longitude from Greenwich.*)	Dybde hvorfra Prøven hentet. (*Depth from which the Samples were collected.*) Engelske Favne. (*English Fathoms.*)	Meter. (*Metres.*)	Aflæste Egenvægter. (*Specific Gravity read.*)	Temperatur. (*Temperature.*) Under Aflæsningen. (*When read.*)	I Havet. (*In Situ.*) t^0	Egenvægter. (*Specific Gravity.*) Ved $\frac{17.^05}{17.^05}$ (*At $\frac{17.^05}{17.^05}$*)	Ved $\frac{t^0}{4^0}$ (*At $\frac{t^0}{4^0}$*)	Chlormængde. (*Amount of Chlorine.*)	Saltmængde. (*Amount of Salt measured.*) Efter Aræometer. (*By the Areometer.*)	Efter Chlormængde. (*By the Amount of Chlorine.*)
281	304	75° 3′	4° 51′ E.	300	549	1.0273	14.9	—0.8	1.0264	1.0278	1.929	3.48	3.49
282	304	75 3	4 51	1735	3173	1.0273	14.5	—1.5	1.0263	1.02775	1.940	3.47	3.51
283	305	75 1.5	7 56	0	0	1.0272	14.8	5.3	1.0263	1.0272	1.947	3.47	3.52
284	306	75 0	10 27	0	0	1.0275	14.1	5.4	1.02645	1.0274	1.929	3.49	3.49
285	306	75 0	10 27	1334	2440	1.0272	14.9	—1.3	1.0263	1.0277	1.920	3.47	3.47
286	310	74 56	13 50	0	0	1.0274	14.7	5.5	1.02645	1.0274	1.936	3.49	3.50
287	310	74 56	13 50	1006	1840	1.0275	13.8	—1.4	1.0264	1.0278	1.932	3.48	3.49
288	316	74 56	16 29	0	0	1.0269	14.7	3.6	1.02595	1.02705	1.903	3.42	3.44
289	316	74 56	16 29	129	236	1.0275	14.6	1.9	1.02655	1.0278	1.930	3.50	3.49
290	321	74 56.5	19 30	25	46	1.0275	9.7	0.2	1.02575	1.0271	—	3.40	—
291	323	72 53.5	21 51	0	0	1.0283	9.7	7.8	1.02655	1.0272	1.947	3.50	3.52
292	323	72 53.5	21 51	223	408	1.0284	8.9	1.5	1.0265	1.0278	1.933	3.50	3.50
293	326	75 31.5	17 50	0	0	1.0276	8.9	4.8	1.02575	1.0267	1.904	3.40	3.44
294	326	75 31.5	17 50	123	225	1.0284	8.7	1.6	1.0265	1.0278	1.930	3.50	3.49
295	328	75 42	15 39	0	0	1.0279	9.9	4.7	1.0262	1.0272	1.908	3.46	3.45
296	328	75 42	15 39	200	366	1.0282	9.8	—1.3	1.02645	1.0279	1.942	3.49	3.51
297	331	75 51	13 5	0	0	—	—	—	—	—	1.935	—	3.50
298	332	75 56	11 36	1140	2101	1.0286	6.3	—1.5	1.0264	1.0279	—	3.48	
299	334	76 12.5	14 0	0	0	1.0275	13.7	6.0	1.0264	1.0272	1.923	3.48	3.48
300	334	76 12.5	14 0	403	737	1.0277	13.7	1.0	1.0266	1.0279	1.935	3.51	3.50
301	335	76 16.5	14 39	0	0	1.0270	15.5	5.4	1.0262	1.0271	1.914	3.46	3.46
302	335	76 16.5	14 39	179	327	1.0276	13.4	1.0	1.0264	1.0277	1.940	3.48	3.51
303	339	76 30	15 39	0	0	1.0267	12.7	2.6	1.0254	1.0266	1.867	3.35	3.38
304	339	76 30	15 39	37	68	1.0273	13.6	0.9	1.02615	1.0275	1.924	3.45	3.48
305	342	76 33	13 18	0	0	1.0277	12.4	6.2	1.02635	1.0272	1.936	3.48	3.50
306	342	76 33	13 18	523	956	1.0277	12.2	—1.0	1.0263	1.0277	1.933	3.47	3.50
307	344	76 42	11 16	0	0	1.0283	6.2	5.2	1.0261	1.0271	—	3.44	—
308	347	76 40.5	7 47	0	0	1.0277	11.3	4.4	1.0262	1.0272	1.924	3.46	3.48
309	347	76 40.5	7 47	1429	2613	1.0278	11.6	—1.3	1.0263	1.02775	1.935	3.47	3.50
310	349	76 30	2 57	0	0	1.0274	11.2	3.8	1.02585	1.0269	1.898	3.41	3.43
311	349	76 30	2 57	1487	2719	1.0277	11.3	—1.5	1.0262	1.0276	1.946	3.46	3.52
312	350	76 26	0 29 W.	0	0	1.0270	10.9	3.0	1.0254	1.0266	1.872	3.35	3.39
313	359	76 26	0 29	300	549	1.0279	10.9	—1.1	1.0263	1.02775	1.922	3.47	3.48
314	350	76 26	0 29	1686	3083	1.0276	10.8	—1.5	1.0260	1.0274	1.916	3.43	3.47
315	352	77 56	3 29 E.	0	0	1.0272	12.8	3.9	1.0259	1.0270	1.908	3.41	3.45
316	352	77 56	3 29	300	549	1.0274	14.0	—0.8	1.0263	1.02775	1.928	3.47	3.49
317	355	78 0	8 32	0	0	1.0275	10.3	4.9	1.0258	1.0268	1.890	3.40	3.42
318	355	78 0	8 32	948	1734	1.0280	9.9	—1.3	1.0263	1.0277	1.927	3.47	3.49
319	357	78 3	11 18	0	0	1.0261	10.9	5.0	1.02455	1.02545	1.797	3.24	3.25
320	359	78 2	9 25	0	0	1.0280	5.3	4.3	1.02575	1.0268	—	3.40	—
321	359	78 2	9 25	416	761	1.0276	13.7	0.8	1.0265	1.0278	1.925	3.50	3.48
322	361	79 8.5	5 28	0	0	1.0278	11.5	4.2	1.0263	1.02735	1.906	3.47	3.45
323	361	79 8.5	5 28	905	1655	1.0272	12.9	—1.2	1.02595	1.02705	1.928	3.42	3.49
324	362	79 59	5 40	0	0	1.0274	13.0	5.2	1.02615	1.0271	1.917	3.45	3.47
325	362	79 59	5 40	459	839	1.0275	12.8	—1.0	1.0262	1.0276	1.922	3.46	3.48
326	363	80 0	8 15	0	0	1.0276	10.9	4.6	1.0260	1.0270	—	3.43	—
327	363	80 0	8 15	260	475	1.0284	7.7	1.1	1.0264	1.0277	1.945	3.48	3.52
328	—	Ved Norskøerne (The Norsk Islands)		0	0	1.0283	4.1	2.7	1.02595	1.0271	—	3.42	-
329	—	Magdalenebay.		0	0	1.0268	12.3	2.2	1.02545	1.0266	—	3.36	—
330	368	78° 43′	8° 20′	0	0	1.0266	13.0	4.6	1.0254	1.02635	—	3.35	—
331	368	78 43	8 20	315	576	1.0286	8.5	1.6	1.0267	1.0280	1.936	3.52	3.50
332	—	78 34	9 22	0	0	1.0262	11.9	4.5	1.0248	1.0258	—	3.27	—
333	372	78 9	14 12	0	0	1.0258	5.0	4.1	1.0236	1.0246	-	3.11	—
334	373	78 10	14 26	0	0	1.0250	12.5	4.0	1.0237	1.0247	—	3.13	—
335	—	Mundingen af Adventbay (Entrance to Advent Bay)		0	0	1.0250	5.3	4.7	1.02285	1.0237	—	3.01	—

Af denne Tabel fremgaar det, at Differentserne mellem de ved Hjælp af Egenvægt og Chlormængde beregnede Saltmængder i Regelen ere meget smaa, kun de 3 samtidig udførte Bestemmelser i Vandprøverne No. 261, 262 og 263 danne i saa Henseende en Undtagelse. De store her optrædende Differentser skyldes uden Tvivl en Feil ved Aflæsningen af Egenvægterne, som for disse Vandprøvers Vedkommende ere fundne altfor lave, til at de kunne bringes i Harmoni med andre paa Steder i Nærheden udførte Observationer. Det er saaledes i høi Grad paafaldende for Vandprøven No. 262, optagen fra et Dyb af 95 Favne (174 Meter) i ca. 8 Miles Afstand fra Land, at finde Egenvægten 1.0254, medens man i de indenfor liggende Fjorde, hvor Saltgehalten ellers overalt er mindre end paa Havet, i lignende Dyb finder en meget større Egenvægt. Selv i den indelukkede Skjærstadfjord, hvor Overfladevandet er særdeles fattigt paa Salte, er dog Egenvægten paa Bunden funden at være 1.026, kort sagt, Egenvægter som de i de omtalte Tilfælde observerede staa paa dette Strøg af Kysten fuldstændig uden Sidestykke. Naturligst lade disse Urimeligheder sig forklare ved at antage Egenvægterne aflæste med 0.001 for lavt, da de ved denne Antagelse paa det Nærmeste kan bringes i Overensstemmelse saavel med de i de samme Vandprøver udførte Chlorbestemmelser som med de andre Observationer fra nærliggende Puncter.

Bortser man fra disse 3 nævnte Observationer og af de øvrige beregner den gjennemsnitlige halve Differents mellem to paa samme Vandprøve ved Hjælp af Chlortitrering og Aræometer udførte Saltbestemmelser, resulterer som Udtryk for denne 0.00904, eller man erholder under Forudsætning af, at Feilene i lige høi Grad skyldes Chlor- som Egenvægtsbestemmelserne, for den gjennemsnitlige Feil af en Egenvægtsbestemmelse Værdien 0.000069 og af en Chlorbestemmelse 0.005. Differentserne falde, som man ser, snart til den ene snart til den anden Side, idet det dog maa bemærkes, at Chlormængden gjennemsnitlig giver lidt over 0.008 % høiere Saltgehalt end Egenvægterne, hvad der næsten udelukkende skyldes de nordenfor den 75de Breddegrad udførte Observationer.

Førend jeg nu gaar over til at give en Oversigt over de Resultater, som af disse Observationer lader sig udlede, vil det være nødvendigt parenthetisk at indskyde nogle Bemærkninger om Dybde- og Temperaturforholdene i det norske Hav i sine groveste Træk. Hvad der til den Ende her meddeles, er hovedsagelig hentet fra en af Professor Dr. Mohn forfattet Afhandling, som findes trykt i C. F. Schübelers "Væxtlivet i Norge."

Dybden i det af den norske Expedition undersøgte Hav, forsaavidt det ligger vestenfor en Linie fra Spitsbergen til det nordlige Norge, er i større Afstand fra Land overalt over 1000 Favne (1829 Meter) og gaar i Regelen op til mellem 1500 og 2000 Favne (2743 og 3658 Meter) eller endog derover. Paa Strøget mellem Beeren Eiland og Jan Mayen hæver sig en Ryg, hvor Dybden ikke naar 1500 Favne (2743 Meter), medens der saavel søndenfor

This Table shows the differences in the amount of salt computed from specific gravity and the proportion of chlorine to be, as a rule, exceedingly small, the 3 determinations performed successively with samples Nos. 261, 262, and 263 constituting the sole exception. The great differences observed here must unquestionably arise from erroneous readings of the specific gravity, which, as found for these samples, is much too low when compared with that determined for others obtained from adjacent localities. Thus, for instance, the specific gravity of sample No. 262, drawn at a depth of 95 fathoms (174 metres), about 8 geographical miles from land, is stated to be 1.0254, whereas that determined for the water of the neighbouring fjords, in which the amount of salt at equal depths is invariably less than in the open sea, was much greater. Even for a frith locked in as is the Skjærstadfjord, where the surface-water is remarkably deficient in salts, the specific gravity of bottom-samples was found to be 1.0260; in short, such exceptional specific gravities are without a parallel on this line of coast. The most natural explanation of these incongruities, is afforded by assuming the specific gravity in each case to have been read 0.001 too low; the results could then be made to agree pretty closely both with the chlorine-determinations performed with the same samples of water and with observations taken in adjacent localities.

Now, if we disregard the 3 exceptional observations, and for the others compute the average half-difference between two salt-determinations performed with the same sample of water by means of the areometer and titrating with chlorine, this will be expressed by 0.00904; or, assuming the errors to lie equally in the chlorine and the specific gravity determinations, the mean error of a specific gravity determination is 0.000069, and of a chlorine-determination 0.005. As will be seen, the differences between the 2 right-hand columns of the Table are sometimes positive, sometimes negative; but the amount of salt indicated by the proportion of chlorine exceeds on an average that denoted by the specific gravity by a trifle over 0.008 per cent, which must be referred almost exclusively to the observations taken north of the 75th parallel of latitude.

Before proceeding to review the results deducible from these observations, it will be necessary to interpolate a few general remarks on the depth and temperature of the Norwegian Sea. To this end, I shall merely recapitulate what Professor Mohn has stated on the subject in a Memoir printed in C. F. Schübeler's "Væxtlivet i Norge."

The depth of the Sea investigated by the Norwegian North-Atlantic Expedition was found to be as follows: — Throughout the tract extending west of an imaginary line drawn from Spitzbergen to the northern extremity of Norway, it is never less than 1000 fathoms (1829 metres) some considerable distance from land, and generally ranges from 1500 to 2000 fathoms (2743—3658 metres); nay, in some places it is even greater. Between Beeren Ei-

som nordenfor findes betydelig større Dyb paa indtil over 2000 Favne (3658 Meter). Østhavet, det vil sige Havet østenfor en Linie fra Spitsbergen til det nordlige Norge, er overalt meget grundt, da Dybden der paa faa Steder overskrider 200 Favne (366 Meter).

De talrige udførte Temperaturobservationer vise, at Vandet i den af Expeditionen undersøgte Del af Østhavet med Undtagelse af den østligste og nordligste Strækning holder Varmegrader ligefra Overfladen til Bunden, saaledes som dette ogsaa er Tilfælde med Vandet paa de norske Banker, som paa enkelte Steder strækker sig ud til en ikke ubetydelig Afstand fra Kysten. Helt anderledes er Forholdet i det vestenfor liggende dybere Hav, som med Hensyn paa Temperaturforholdene naturlig kan inddeles i 2 Hovedstrøg, den i den østlige Del nordover gaaende saakaldte Golfstrøm og den i den vestlige Del sydover gaaende østgrønlandske Polarstrøm. Grændsen mellem disse gaar nordenom Island op til Jan Mayen, bøier i en Bue sondenom og østenom denne og overskrider paa omkring 3° vestlig Længde med nordostlig Retning den 71de Breddegrad. Herfra gaar den mod Øst til henimod 7° østlig Længde og fortsætter derfra i nordlig og lidt vestlig Retning til nordenom den 80de Breddegrad.

I den østenfor denne Grændse beliggende Del af Havet besidder Overfladevandet en forholdsvis høi Temperatur, der endog overskrider Luftens midt om Sommeren, hvorhos ogsaa Vandet i de nærmest under Overfladen beliggende Lag holder Varmegrader, saaledes at 0° først forefindes i et Dyb af omkring 500 Favne (914 Meter), hvorfra Temperaturen jevnt og langsomt synker til omkring —1.°3 ved Havbunden.

I den østgrønlandske Koldvandsstrøm er derimod Temperaturen i selve Overfladen meget lav men om Sommeren i isfrit Vand dog overalt over 0°, medens den allerede fra faa Favnes Dyb og nedover lige til Bunden holder sig under 0°.

Med Hensyn paa Saltgehalten i Overfladevandet henvises til Kartet No. I, hvori findes indtegnet en større Del af de Tal, der fremgaa som Middel af de efter Chlor- og Egenvægtsbestemmelserne beregnede Værdier for Saltmængden. Efter disse Observationer findes ogsaa optrukket Grændserne for 3.55, 3.50, 3.45 og 3.40 % Salt, saaledes som deres Form maa antages at være i Sommermaanederne. Kartet viser, at den i Syd ind i det norske Hav strømmende Varmvandsstrøm fører Vand af temmelig stor Saltgehalt, som i de sydligste Egne paa begge Sider af Færøerne gaar op til 3.55 % eller endog derover. Herfra gaar Strømmen videre i nordostlig Retning med noget lavere Saltgehalt (omkring 3.525 %) indtil henimod Beeren Eiland, hvor den deler sig og sender en Arm mod Øst ind i Østhavet og en anden i nordlig og noget vestlig Retning

land and Jan Mayen there is a vast ridge, and here the depth does not reach 1500 fathoms (2743 metres); but south and north of that ridge it is much greater, in some localities more than 2000 fathoms (3658 metres). Barents' Sea, or the tract of ocean stretching between Novaja Zemlja and an imaginary line drawn from Spitzbergen to the northern extremity of Norway, is everywhere exceedingly shallow, the depth in but few places reaching above 200 fathoms (366 metres).

The extensive series of observations shows that the temperature of the water throughout the part of Barents' Sea investigated by the Expedition, saving the most easterly and northerly tracts, exhibits everywhere a temperature above zero, from the surface to the bottom, as is also the case with the water on the great Norwegian banks, which, in certain localities, extend to a considerable distance from the coast. A very different relation rules in the deep western section, which, as regards temperature, may be divided into two principal tracts, an eastern, with the Gulf Stream, as it is called, flowing north, and a western, with the Arctic current, flowing south, along the shores of East Greenland. The boundary-line between these two currents extends north of Iceland to the island of Jan Mayen, where it makes a bend southward and eastward, crossing, in longitude about 3° W., with a north-easterly direction, the 71st parallel of latitude. From thence it runs east, and, when in longitude about 7° E., takes a northerly and somewhat westerly direction, continuing on past the 80th parallel of latitude.

In the tract of ocean stretching to the east of this boundary, the temperature of the surface-water is comparatively high, exceeding even that of the atmosphere in the middle of summer; the water, too, some distance below the surface exhibits a temperature above zero, the depth at which 0° is reached being about 500 fathoms (914 metres), from which the temperature sinks slowly and gradually to about —1.°3, at the bottom.

In the cold East Greenland current, the temperature at the surface is on the other hand exceedingly low, though in summer above zero where the water is free from ice; 0° however is reached at the depth of a few fathoms.

As regards the amount of salt in the surface-water, the reader is referred to Plate I, in which will be found most of the figures representing the mean values, deduced from the chlorine and specific gravity-determinations, for the proportion of salt. In Pl. I, too, are laid down curves constructed from these results, to show the limits of distribution for the following percentages of salt: 3.55, 3.50, 3.45, and 3.40, as they may be assumed to extend in the summer months. The warm current, flowing from the south into the Norwegian Sea, brings with it, as shown by the Plate, an indraught of water containing a comparatively large amount of salt, the maximum percentage, upwards of 3.55, being reached in the most southerly tracts, along the eastern and western shores of the Feröe Islands. From thence, with a slightly reduced amount of salt (about 3.525), the

forbi Spitsbergens Vestkyst. I den mod Øst gaaende Gren synker Saltgehalten meget langsomt og jevnt, indtil den ved Grændsen af det af Expeditionen undersøgte Felt har naaet 3.50 %, medens den i den nordover flydende Arm meget hurtigt synker til endog under 3.45 % for atter ved Spitsbergens Nordvestkyst at hæve sig til lidt over 3.45 %.

Denne i Vest for Spitsbergen forefundne ringe Saltholdighed i Overfladen er dog sandsynligvis kun eiendommelig for den varmere Aarstid, da der fra Spitsbergens mægtige Is- og Snebræer flyder store Mængder Ferskvand ned i det tilstødende Hav.

Indflydelsen af saadant fra Kysterne udgaaende Ferskvand indskrænker sig dog hovedsagelig kun til meget smaa Dyb, da det saavel af disse som tidligere publicerede Undersøgelser af samme Art fremgaar, at et over saltere Vand flydende ferskere Overfladelag besidder en mærkelig Evne til meget længe at holde sig forholdsvis ublandet, saaledes at den fra Kysterne hidrørende Fortynding i Overfladen ofte kan spores 30 til 40 Mile tilhavs, medens man ved Bunden i Nærheden af Land ja endog i Fjordene kan finde meget saltholdigt Vand. Denne Eiendommelighed træder meget skarpt frem i Observationsrækken No. 1 til 8.[1] da Saltgehalten her fra Overfladen til 1 Favns (2 Meters) Dyb tiltager med over 1 %, medens den siden temmelig jevnt voxer med kun 0.06 % for hver Favns Tilvæxt af Dybden. De paa Spitsbergens Banker tagne Observationer viser da ogsaa ganske rigtigt, at Vandet der paa Bunden i nogen Afstand fra Land besidder en Saltstyrke, som paa sine Steder endog gaar op til over 3.50 %.

Paa begge Sider af den midt efter det norske Hav flydende salte Overfladestrøm synker Saltgehalten paa den ene Side mod den norske Kyst og paa den anden Side mod den østgrønlandske Polarstrøm, en Synkning, som paa Grund af de herskende Strømforholde hverken er jevn eller regelmæssig. Saaledes flyder der fra Nordsøen langs Norges Vestkyst i nordlig Retning en lidet saltholdig Overfladestrøm, som ved den 62de Breddegrad, hvor Kysten bøier nordostover, forlader denne, og fortsætter fremdeles i nordlig Retning, indtil dens Virkninger i omtrent 40 Miles Afstand fra Land efterhaanden taber sig. En mindre udpræget lignende Kyststrøm gaar fra Vestfjorden udover i sydvestlig Retning og naar ligeledes temmelig langt tilhavs, førend dens Indflydelse paa Saltgehalten i Overfladevandet fuldstændig forsvinder. Mellem disse Kyststrømme kaster der sig en smal Arm af det saltere Atlanterhavsvand forholdsvis nær ind under Land, hvor den meget skarpt

[1] Disse Observationer kunne desuden ogsaa tjene som Bevis for Fortrinligheden af den af Ekman angivne Vandhenter, som ved denne Leilighed benyttedes.

current flows in a north-easterly direction, as far north almost as Beeren Eiland, where it divides into two arms, one running east into Barents' Sea, and the other in a north-westerly direction past the west coast of Spitzbergen. In the branch flowing east, the amount of salt diminishes very slowly and gradually down to 3.50 per cent, at the limit of the region explored by the Expedition, whereas in that running north it rapidly sinks even below 3.45 per cent, rising, however, on the north-western coast of Spitzbergen a little above 3.45 per cent.

This low percentage of salt in the surface-water west of Spitzbergen is, however, in all probability the result of summer heat, vast quantities of freshwater pouring down to the sea at that season of the year from the immense glaciers and snow-fields of that group of islands.

The effect of such an influx of fresh water from the coast is, however, mostly confined to a very trifling depth, the result of the observations taken on the Expedition, and of others in connexion with the same subject previously published, being to show, *inter alia,* that freshwater possesses the remarkable property of floating on salt water for some considerable time in a comparatively unmixed state, so that its influence may be frequently traced at a distance of from 30 to 40 geographical miles off shore, whereas the bottom-water close in shore, nay that of friths and estuaries even, often contains a very large proportion of salt. This peculiar feature was strikingly instanced in the series of observations from No. 1 to 8.[1] the amount of salt at the depth of 1 fathom (2 metres) exceeding that at the surface by 1 per cent, whereas the subsequent increase with the depth did not amount to more than 0.06 per cent for every fathom. The observations taken on the banks of Spitzbergen show that the maximum percentage of salt in the bottom-water some distance from land, in certain localities, reaches 3.50.

On either side of the salt surface-current flowing through the medial portion of the Norwegian Sea, the amount of salt diminishes, eastward in the direction of the Norwegian coast and westward in the direction of the Arctic current off East Greenland; but this diminution, owing to the effect of ocean currents, is however anything but regular and gradual. Thus, for instance, a surface-current, with a low percentage of salt, flows from the North Sea in a northerly direction along the west coast of Norway, from which it diverges near the 62nd parallel of latitude, continuing on, still in a northerly direction, till, about 40 geographical miles from land, its influence gradually ceases to be felt. Another coastal current, more limited in extent, flows from the Vestfjord in a south-westerly direction, its influence on the amount of salt in the surface-water being likewise perceptible comparatively far out at sea. Between these coastal currents runs a narrow arm

[1] These observations likewise attest the excellence of Ekman's apparatus for collecting sea-water, which was used on this occasion.

afgrændser sig mod det indenfor flydende meget ferskere Vand. Forøvrigt holder Grændsen for det saltere Overfladevand sig meget langt tilhavs med Undtagelse af, at den ved den 70de Breddegrad paa en ganske kort Strækning kaster sig tæt ind under Kysten.

Denne Fortynding af Overfladevandet, som overalt ytrer sig ved den norske Kyst, er intetsteds ledsaget af nogen væsentlig Forrykkelse af Overfladetemperaturen. Saltgehaltens Formindskelse skyldes her aabenbart det fra Kysterne udstrømmende Flodvand, der om Sommeren besidder en ikke ringe Varmegrad, saaledes at man i den mest fremtrædende Kyststrøm langs Norges Vestkyst endog finder en noget høiere Overfladetemperatur end paa nærliggende Puncter. Ganske anderledes stiller Sagen sig paa den mod den østgrønlanske Polarstrøm vendende Side, hvor Overfladevandet fortyndes ikke ved Flodvand men ved det ved Havisens Smeltning dannede, stærkt afkjølede Ferskvand, og det viser sig derfor, at en Synken i Saltgehalten her bestandig er ledsaget af en tilsvarende Formindskelse af Overfladetemperaturen. Grændsen for det saltere Vand i Overfladen følger derfor paa denne Side ofte Polarstrømmens Grændse, og selv der, hvor den forlader denne, optræder der dog samtidig med Overgangen fra saltere til ferskere Vand altid meget tydelige Variationer i Temperaturen, der gaa i samme Retning som Saltgehaltens. At Overfladetemperaturen synker, naar man enten nærmer sig eller overskrider Grændsen for 3.50 % Salt, vise Observationerne No. 115 til 120 og No. 207 til 209.

I selve Polarstrømmen er Saltgehalten i Overfladen i nogen Afstand fra Grændsen oftest fundet meget lav, kun paa et Sted optræder i saa Henseende en Undtagelse fra den almindelige Regel, idet der omtrent paa den 75de Breddegrad skyder sig en smal Tunge med Vand af høiere Saltstyrke ind over Polarstømmen, uden at der dog derved bevirkes nogen væsentlig Forhøielse af Overfladetemperaturen. En Mærkelighed, som fortjener at omtales, er den, at Professor Dr. G. O. Sars, som paa Expeditionens Togter jevnlig undersøgte Dyrelivet i Overfladen, netop paa dette Punct langt inde i Polarstrømmen har gjenfundet de for det varmere Atlanterhavsvand eiendommelige Dyreformer, der forresten intetsteds ellers ere fundne i den østgrønlandske Koldvandsstrøm.

Med Hensyn paa Saltmængderne i de større Dyb henvises til Kartet No. II, hvori paa samme Maade som ovenfor findes indtegnet Saltgehalten ved Havbunden samt i de intermediære Dyb, forsaavidt Observationerne refererer sig til Puncter saa dybt under Overfladen, at Temperaturen der ligger under 0°. Hvor en Observation hidrører fra et intermediært Dyb, er Tallet i Kartet understroget.

Naar man bortser fra enkelte i Nærheden af Kysterne og paa grundt Vand optagne Vandprøver, varierer Saltgehalten paa de store Dyb mellem 3.59 og 3.45 %,

of the salt ocean-water of the Atlantic, distant but a few miles from land, its boundary being distinctly marked by the limits of the brackish water flowing along the shore. Except in this region, and a locality bordering the 70th parallel of latitude, where, for a short distance, it runs close to the coast, the boundary of the salt surface-water lies far out at sea.

This dilution of the surface-water on all parts of the Norwegian coast is not anywhere found to exert a material influence on the surface-temperature. The decrease in the amount of salt must be obviously ascribed to the influx of river-water, the temperature of which during the summer months is relatively high, — so high indeed, that the principal coastal current, flowing along the western shores of Norway, has a somewhat higher surface-temperature than that observed in its immediate vicinity. Phenomena the reverse of these prevail in the tract of ocean exposed to the influence of the Arctic, or East Greenland, current. There, the surface-water is not diluted by an influx of river-water, but with freshwater of a low temperature, produced by the melting of drift-ice; and hence a decrease in the percentage of salt is invariably attended with a corresponding reduction of the surface-temperature. The salt surface-water borders, therefore, not infrequently the Arctic current; and even where its boundary diverges from it, the transition from salt to comparatively fresh water is always accompained by a very considerable variation in temperature, proportionate to the variation in the amount of salt. That the surface-temperature becomes gradually lower on approaching the limits of the section in which the proportion of salt is 3.50 per cent, will be seen from the series of observations Nos. 115—120 and Nos. 207—209.

In the Arctic current, some distance from its extreme boundary, the proportion of salt at the surface was found to be very small, except in one locality, near the 75th parallel of latitude, where a narrow strip of salter water flows into the current, without, however, causing an appreciable rise in the surface-temperature. It is a remarkable fact, which must not be passed by unnoticed, that Professor G. O. Sars, naturalist to the Expedition, found here in the surface-water, which he examined from day to day, forms of animal life peculiar to the warm area of the Atlantic water, which he never met with in any other part of the cold East Greenland current.

As regards the amount of salt observed at great depths, the reader is referred to Pl. II, in which, as in Pl. I, will be found the percentage both at the bottom and at intermediate depths, provided the observations were taken with samples of water the temperature of which *in situ* was below 0°. Observations with water from intermediate depths are denoted by underlining the figures expressing their results.

Disregarding a few samples of water collected near the coast and in shallow spots, the proportion of salt, where the depth is great, ranges from 3.59 to 3.45 per

og Differentserne ere saaledes ogsaa her vel paaviselige om end mindre end i Overfladen. For tydeligt at kunne markere disse optrædende Differentser paa en let overskuelig Maade, har jeg benyttet forskjellige Farver. Saaledes ere de Strøg, hvor Saltgehalten beløber sig til 3.50 % eller derunder, betegnede med blaa Farve, de Strøg, hvor Saltgehalten ligger mellem 3.50 og 3.55 %, med rød Farve, medens de Vandmasser, der ifølge Observationerne besidde en Saltmængde af over 3.55 %, ere tegnede med en noget kraftigere rød Farve. I Nærheden af Kysterne er Kartet overalt ufarvet uden Hensyn til, om Vandet der henhører under den ene eller den anden af de tre Hovedgrupper.

Den uregelmæssige Fordeling af Saltgehalten i de større Dyb, som det saaledes tegnede Kart udviser, maa unegtelig betegnes som meget paafaldende. At Saltmængderne paa Bankerne og i den sydlige Del af Østhavet paa det Nærmeste findes at svare til den, som det i Overfladen svømmende varme Atlanterhavsvand besidder, kan ikke synes overraskende. Havet er her meget grundt, og det deri flydende Vand besidder overalt en Temperatur af over 0° og maa saaledes nærmest henføres til den nordover flydende Atlanterhavsstrøm, med hvilken det da ogsaa helt naturligt har Saltgehalt tilfælles. Ligeoverfor de store Dyb maatte man derimod paa Forhaand vente et andet Resultat. Temperaturen ligger her uden Undtagelse under 0° ja paa de fleste Steder endog under —1°, og det kunde derfor synes rimeligst at tilskrive det der flydende Vand polar Oprindelse. Det fremgaar imidlertid med Bestemthed af alle mig bekjendte Undersøgelser over Saltmængderne i de forskjellige Have, at de fra arktiske Egne udgaaende Strømme uden Undtagelse fører Vand af lavere Saltgehalt end de fra de mere tempererede Himmelstrøg udgaaende Varmvandsstrømme, og man skulde derfor i de dybere og koldere Lag af det her undersøgte Hav vente at finde en Vandmasse med adskilligt lavere Saltgehalt end den, der er funden i det i Overfladen og nærmest under den flydende Vand, som aabenbart skriver sig fra varmere Egne. Hvad der virkelig finder Sted er desuagtet dette, at det i de dybere liggende Lag flydende, iskolde Vand paa store Strækninger viser sig at have en Saltgehalt, der temmelig nøie svarer til den, der er funden i den atlantiske Overfladestrøm.

Saavel af denne Grund som ogsaa af andre Grunde, som jeg senere skal fremføre, finder jeg det rimeligt at gjøre den Antagelse, at Vandet paa de større Dyb paa de Steder, som i Kartet findes aflagte med rød Farve, enten udelukkende skriver sig fra varmere Egne eller under enhver Omstændighed er saa opblandet med saadant Vand, at det Hele derved antager en tydelig atlantisk Karakter, medens Vandet i de med blaa Farve betegnede Strækninger mere eller mindre skarpt udpræger sig som hidrørende fra polar Oprindelse.

Hvor det gjælder at besvare Spørgsmaalet om, hvorledes de øvre Lag finder Vei ned til Bunden, da synes dette ikke at kunne besvares paa anden Maade, end at det atlantiske Vand under stadig Afkjøling maa synke gjennem det iskolde og fordrive dette, under enhver Omstæn-

cent; and there too, accordingly, the differences are appreciable, though smaller than at the surface. For the better apprehension of these differences, the sections in which they occur have been differently coloured in the Plate: blue indicates a percentage of 3.50, and under; red, a percentage ranging from 3.50 to 3.55; and a somewhat deeper red, a higher percentage than 3.55. Along the coasts, the Plate is left uncoloured, no matter to which of the three principal groups the water there belongs.

This irregular distribution of the amount of salt at great depths, as shown in the Plate, is certainly a most remarkable phenomenon. That the proportion of salt on the banks and in the southern portion of Barents' Sea should agree pretty closely with that contained in the warm surface-water of the Atlantic, is not indeed surprising: the depth is in both localities comparatively trifling, and the water, having everywhere a temperature above 0°, must be referred to the warm Atlantic current; its percentage of salt is therefore naturally the same as that of the Gulf Stream. For the great depths, on the other hand, there was reason to expect a very different result. Here, the temperature is without exception below 0°, nay in most places below —1°; and hence, as regards the origin of such water, there seems much to urge in favour of an indraught from the Polar Sea. Of the observations undertaken to determine the amount of salt in sea-water, all with which I am acquainted furnish incontestible proof that the water of the currents flowing from the Arctic Ocean has a lower percentage of salt than that of the warm currents flowing from more temperate regions; and the proportion of salt in the deeper and colder strata of the tract of ocean explored by the Expedition was expected, therefore, to prove considerably lower than that observed at the surface or a short distance beneath it, where the water is obviously an influx from warmer climes. But such was not the case, for the amount of salt found in the water of the cold area, where the temperature is below zero, agrees, in some localities, pretty closely with that in the water of the Atlanic surface-current.

This phenomenon, in conjunction with reasons that will afterwards be explained, has led me to assume, that the water met with at great depths in the sections coloured red in the Plate, is either exclusively the result of an influx from warmer regions, or is, at least, so mixed with such water as to have distinctly acquired Atlantic characteristics; whereas the water in the blue-coloured sections would seem to indicate more or less determinately a Polar origin.

As to the question involved in the descent of the upper strata to the bottom, the only way in which this can take place seems to be by the Atlantic surface-water, as it parts with its excess of heat, gradually sinking through the water of the cold area, and displacing it; at all events,

dighed synes det sikkert, at man for det afgrændsede ostenfor Jan Mayen beliggende Strog ikke kan antage nogen anden Vei. Men at den varmere Vandmasse saaledes skulde synke gjennem den koldere, kunde jo ved første Oiekast synes stridende mod vel kjendte Naturlove, da man nærmest maatte tro, at det i Nærheden af Overfladen flydende atlantiske Vand paa Grund af sin høiere Temperatur skulde være specifisk lettere end det ifølge sin lave Temperatur stærkt fortættede Bundvand. Nærmest for at fjerne enhver Tvivl i saa Henseende, er der i den forhen gjengivne Tabel opført en Rubrik for Vandprøvernes Egenvægter ved den i Havet observerede Temperatur i Forhold til rent Vand af 4°. Ved Hjælp af de der beregnede Tal kan man med Lethed studere den specifiske Vægts Variation med Dybden, saaledes som den finder Sted i Havet, bortseet fra den ved Vandets Sammentrykkelighed foraarsagede Fortætning i de større Dyb.

Den Region, som i denne Henseende mest interesserer os, er den, hvori der i Overfladen og nærmest under den findes en bestemt udpræget atlantisk Varmvandsstrøm, en Region, som paa det Nærmeste falder sammen med den søndenfor en Linie fra Island til Beeren Eiland liggende Del af Havet, dog saaledes at det nærmest Norge liggende Parti paa Grund af den fra Kysterne udgaaende Fortynding maa bortskjæres. Grupperer man de i denne Egn tagne Observationer over Saltgehalt og den specifiske Vægt reduceret til Havets Temperatur og en Atmosphæres Tryk efter Dybden, fremgaar som Resultat heraf Følgende.

Dybdeinterval.		Midlere Dybde.		Midlere Saltgehalt %	Midlere Egenvægt ved Havets Temperatur.
Engelske Favne.	Meter.	Engelske Favne.	Meter.		
0	0	0	0	3.526	1.02688
0—300	0—549	167	305	3.514	1.02782
300—600	549—1097	502	918	3.521	1.02812
600—1000	1097—1829	681	1245	3.513	1.02802
1000—1500	1829—2743	1203	2200	3.506	1.02800
under 1500	under 2743	1688	3087	3.507	1.02800

Det i denne Tabel erholdte Tal for Saltgehalten paa Strøget mellem 0 og 300 Favnes (0 og 549 Meters) Dyb er imidlertid uden Tvivl for lavt, da en uforholdsmæssig stor Del af Observationerne i dette Dyb hidrøre fra Osthavet, hvor Saltgehalten overalt er mindre end i de centrale og sydlige Dele af Feltet. De Observationer, som skrive sig fra dette Dyb i større Afstand fra Kysten, tyde hen paa, at Saltgehalten der meget nær svarer til den, der er funden i Overfladen paa de samme Steder. Denne Mislighed ved den geografiske Fordeling af Observationerne fra de mindre Dyb faar derimod ingen væsentlig Indflydelse paa det som Middel af de specifiske Vægter erholdte Tal, da den i de nordligere Egne ved Saltgehaltens Synkning foraarsagede Formindskelse af Egenvægterne paa det Nær-

it is certain that no other plausible explanation can be given of the phenomenon for the region east of Jan Mayen. But, that water of a higher temperature should sink in this manner through water of a lower, appears at first sight to be at variance with well-known physical laws; for the water from the Atlantic current having a higher temperature, one would imagine it to be specifically lighter than the cold and dense bottom-water. With the object of dispelling every doubt that might arise in connexion with this subject, a column has been added to the Table given above for the specific gravity of the samples of water at their temperature *in situ*, as compared with that of pure water of 4°. By means of the figures set down in the column, the variation of the specific gravity with the depth, as it occurs in the sea irrespective of increased density from the compressibility of water at great depths, may be readily investigated.

The tract of ocean which in this respect it will be most desirable to investigate, is that through which flows, on or near the surface, a warm current, setting from the Atlantic, — a tract which nearly coincides with the region stretching south of an imaginary line drawn from Iceland to Beeren Eiland, but from which, owing to the influx of freshwater, must be cut off the section extending along the Norwegian coast. Now, if we group together the observations taken in this part of the North-Atlantic to determine the percentage of salt and the specific gravity reduced to the temperature of the sea and a pressure of one atmosphere, the result will be as follows: —

Intervals of Depth.		Mean Depth.		Mean Amount of Salt per cent.	Mean Sp. Gr. at the Temp. of the Sea.
English Fathoms.	Metres.	English Fathoms.	Metres.		
0	0	0	0	3.526	1.02688
0—300	0—549	167	305	3.514	1.02782
300—600	549—1097	502	918	3.521	1.02812
600—1000	1097—1829	681	1245	3.513	1.02802
1000—1500	1829—2743	1203	2200	3.506	1.02800
below 1500	below 2743	1688	3087	3.507	1.02800

The figures in this Table expressing the amount of salt at depths ranging from 0 to 300 fathoms (0—549 metres) are, however, unquestionably too low, seeing that a disproportionate number of the observations at this depth were taken in Barents' Sea, where the amount of salt is everywhere smaller than in the central and southern sections of the tract investigated. The observations referring to this depth at a considerable distance from land, show that the percentage of salt is very nearly the same as that at the surface. The said defect in the geographical distribution of the observations taken at a comparatively trifling depth, does not however materially affect the correctness of the figures expressing the mean specific gravity; for the fall in specific gravity occasioned in northern regions

meste opveies af den Forøgelse af samme, der skyldes de der herskende lavere Temperaturer.

Det fremgaar altsaa, at Differentserne mellem Saltgehalten i de atlantiske Overfladelag og de paa Bunden hvilende iskolde Vandmasser gjennemsnitlig kun ere meget smaa, om de end paa de Puncter, hvor Vandet i de dybere Lag besidder en overveiende polar Karakter, turde være adskilligt mere fremtrædende. Disse Differentser af henimod 0.02 % ere dog mere end tilstrækkelig store til i de nederste mere afkjølede Lag af det atlantiske Vand at fremkalde et, som det vil sees af Tabellen, meget tydeligt om end svagt Maximum af den specifiske Vægt, hvad der nærmest bevirkes derved, at Søvandet ved Afkjøling under 0° nærmer sig sit Tæthedsmaximum og derfor i Nærheden af dette for mindre Temperaturvariationer kun forandrer sit Volum med næsten umærkelig smaa Værdier, saaledes at en selv meget ringe Forøgelse af Saltgehalten under disse Omstændigheder faar en overveiende Indflydelse ligeoverfor en Grads Forandring af Temperaturen.

Det er saaledes saa langt fra Tilfælde, at der i de specifiske Vægter af de forskjellige Vandlag ligger nogen Hindring for Antagelsen af, at det atlantiske Vand skulde synke gjennem det koldere Polarvand, at man tvertom af disse maa slutte, at saa maa være Tilfælde, dersom ikke andre i Havet herskende Strømme virke hemmende paa en saadan Bevægelse. Man tænke sig f. Ex. ved Siden af hinanden i Havet to Vandsøiler af 2000 Favnes (3658 Meters) Dybde, hvori Temperaturens Variation med Dybden for Simpelheds Skyld kan antages at være den samme, hvorimod Saltgehalten i den 1ste helt igjennem sættes til 3.52 %, medens den i den 2den paa Strøget fra Overfladen til 500 Favnes (914 Meters) Dyb gives Værdien 3.52 % og fra 500 til 2000 (914 til 3658) Værdien 3.50 %, saaledes som Forholdet ifølge Observationerne virkelig synes at stille sig paa enkelte Steder i det undersøgte Hav. Det er da umiddelbart indlysende, at en saadan Fordeling af Saltgehalten vil have en Synkning i den 1ste Søile til Følge, saaledes at Vandet i denne vil søge at udbrede sig langs Bunden og fordrive det omliggende specifisk lettere Vand. Den Hastighed, hvormed en saadan Bevægelse foregaar, vil naturligvis rette sig efter Differentsen mellem Trykkene i samme Niveau i begge Søiler, en Differents, som ved Bunden i 2000 Favnes (3658 Meters) Dyb efter Beregning beløber sig til henimod 32 mm Kviksølvsøile.

For nærmere at begrunde den forhen fremsatte Hypothese, om at det paa Bunden hvilende iskolde Vand paa de i Kartet med rød Farve betegnede Steder skulde have atlantisk Oprindelse, vil jeg benytte mig af de i en tidligere Afhandling[1] beskrevne Observationer over de i Søvandet indeholdte Kvælstofmængder, hvis Anvendelse i saadant Øiemed allerede paa det Sted løselig er bleven antydet.

Som bekjendt herskede der i ældre Tider den Anskuelse, at de i Søvandet i de større Dyb indeholdte Luftmængder paa Grund af det der herskende Tryk maatte

[1] "Om Luften i Søvandet."

by a decrease in the amount of salt, is almost compensated by the rise resulting from the low temperatures prevailing there.

It appears, therefore, that the differences between the amount of salt in the warm upper strata and that in the cold water at the bottom, are, on an average, exceedingly small, though more striking perhaps in localities where the water of the deeper strata to a very great extent is Polar in origin. These differences — about 0.02 per cent — are, however, as will be seen from the Table, more than sufficient in the deepest and coldest strata of Atlantic water to occasion an appreciable, though a low, maximum of specific gravity, which is explained by the fact, that seawater below 0° has very nearly reached its maximum of density, and the increase in volume then resulting from trifling variations in temperature, is a well nigh inappreciable magnitude: hence, under such circumstances, the influence of a very slight addition to the amount of salt with but one degree's difference in temperature will be exceedingly great.

Such being the case, there is nothing in the specific gravities observed in the different strata of water to disfavour the assumption that the comparatively warm Atlantic water should sink through the cold water of Polar origin; nay, from these specific gravities we may infer its correctness, provided only that such descending motion be not counteracted by the effect of ocean currents. To give an illustration. Let us imagine two columns of water, 2000 fathoms (3658 metres) deep, in both of which, for convenience' sake, the variation in temperature with the depth is assumed to be equal; the amount of salt on the other hand, being put at 3.52 per cent throughout the whole of the first, but in the second, at 3.52 per cent from the surface to a depth of 500 fathoms (914 metres), at 3.50 per cent from 500 to 2000 fathoms (914—3658 metres), — a ratio of distribution actually observed in some localities. This given, it is obvious that such a distribution must cause the water in the first column to sink, and spread itself over the bottom, displacing as it does so the specifically lighter. The rapidity of this downward motion will of course be proportionate with the difference in pressure at the same level in the two columns, a difference which, at the depth of 2000 fathoms (3658 metres), has been computed equal to that of a column of mercury 32 mm in height.

With a view to furnish additional confirmation of the hypothesis brought forward above, which assumes the cold bottom-water in the red-coloured sections of the Plate to be of Atlantic origin, I shall have recourse to my observations on the amount of nitrogen in sea-water, published in a former paper,[1] where their application to such a purpose was briefly alluded to.

The opinion formerly entertained, that the quantity of air contained in sea-water at great depths must be exceedingly great, by reason of the immense pressure pre-

[1] "On the Air in Sea-Water."

være uforholdsmæssig store, en Anskuelse, som ved de senere Undersøgelser fuldstændig er bleven modbevist. Rigtignok er det paa den engelske Challengerexpedition iagttaget, at de i den hede Zone fra Havbunden optagne Vandprøver ved at henstaa nogen Tid vise Overmætningsphænomener, men dette vil jo ikke være vanskeligt at forklare, naar man erindrer, at Vandet i de store Dyb selv i Æqvatoregnene er meget nær iskoldt. Det følger nemlig af sig selv, at de til en saa lav Temperatur svarende Luftmængder ikke kunne holdes opløste, naar Vandprøverne ved længere Tids Henstand antager de tropiske Egnes høie Lufttemperatur. Stærkest taler de paa den norske Expedition udførte Luftbestemmelser for, at Tryktilvæxten med Dybden ikke kan have nogen Indflydelse paa Mængden af den i Søvandet opløste Luft. Tager man nemlig Middelet af Dybder, Temperaturer og Kvælstofmængder for alle de fra Puncter under Overfladen stammende Vandprøver, hvori der paa denne Expedition er foretaget Luftbestemmelser, erholder man til et Middeldyb 693 Favne (1267 Meter) en Middeltemperatur — 0.°05 og en midlere Kvælstofgehalt 13.99 CC. per Litre, det vil sige, Vandet i Dybet indeholder gjennemsnitlig næsten 0.5 CC. Kvælstof *mindre*, end det ved sin Temperatur vilde kunne holde opløst under en Atmosphæres Tryk.

Naar man erindrer, at Trykket i Havdybene ikke dreier sig om Atmosphærer men om Hundreder af Atmosphærer, saa maatte man dog vente, at dets Indflydelse (om det havde nogen) vilde give sig tilkjende ved Uregelmæssigheder af paaviselig Størrelse, og man er, da dette ikke i mindste Maade er Tilfældet, berettiget til den Slutning, at Trykket ikke besidder nogen Evne til i mærkbar Grad at ophobe Luftmængderne i de store Dyb. Paa den anden Side maa det fornuftigvis antages, at Vandet i de dybere liggende Lag ikke kan afgive noget af sin Luft, da det jo paa Grund af det der herskende Tryk vil kunne holde opløst overveiende større Mængder end de, der nogensinde ere forefundne.

Den rimeligste Slutning af de senere Tiders Observationer over disse Gjenstande vil saaledes være den, at en Vandprøve, saalænge den befinder sig under Overfladen, uforandret vil beholde den samme Luftmængde eller rigtigere Kvælstofmængde[1], som den havde absorberet, da den sidste Gang befandt sig i Overfladen udsat for Luftens frie Indvirkning.

Nu er den Luftmængde, som Søvandet absorberer af Atmosphæren, hovedsagelig afhængig af Vandets Temperatur, idet Barometerstandens Variationer ligeoverfor større Temperaturdifferentser kun har en underordnet Betydning. Heraf følger, at de Vandmasser, der have absorberet sin Luftmængde under varmere Himmelstrog, maa være forholdsvis

[1] Den absorberede Surstofmængde er nemlig i nogen Grad afhængig af Dyrelivet og andre Tilfældigheder, saaledes at det her ligesom i den tidligere Afhandling vil være det Rigtigste at anvende Kvælstofmængden som Maal for den samlede Luftmængde.

vailing there, has been wholly refuted by the results of later observations. True, the samples of water obtained at great depths within the tropics on the 'Challenger' Expedition were found to exhibit the phenomena of supersaturation when allowed to stand over some time; this, however, is easily explained, if we call to mind that the water at great depths, even in equatorial regions, has a temperature but little above zero. Hence it naturally follows, that the quantity of air corresponding to so low a temperature cannot be retained on the samples of water having stood over sufficiently long to acquire the high temperature of the atmosphere in tropical climates. The air-determinations performed on the Norwegian Expedition afford the strongest proof of the fact, that the increase of pressure with the depth does not exert any appreciable influence on the proportion of air in sea-water. Now, if we compute the mean depth, temperature, and amount of nitrogen for all the samples of water from below the surface examined for air-determinations, the result will be as follows: mean depth 693 fathoms (1267 metres); mean temperature — 0.°05; mean amount of nitrogen 13.99^{cc} per litre, which shows that in the depths of the ocean the proportion of nitrogen averages 0.5^{cc} *less* than could be absorbed by sea-water of the temperature prevailing there with the pressure of one atmosphere.

If we call to mind that the pressure in the depths of the sea is not computed even by tens, but by hundreds of atmospheres, its influence, if any, must surely, one would imagine, occasion irregularities of appreciable magnitude; and we may therefore safely conclude, since no such disturbance can be detected, that pressure does not perceptibly increase the amount of air at great depths. On the other hand, there is every reason to infer, that the water in the lower strata, owing to the immense pressure, cannot part with any of its air, the quantity actually absorbed never being even approximately so great as such a pressure would enable it to retain.

From the latest observations throwing light on this question, we may therefore reasonably infer, that all sea-water below the surface retains undiminished the quantity of air, or rather of nitrogen,[1] which it absorbed when last at the surface, in direct contact with the atmosphere.

Now, the quantity of air absorbed by sea-water is mainly dependent on the temperature of the latter, the rise or fall of the barometer, as compared with considerable differences in temperature, being in this case of but little moment. Hence it follows, that the proportion of air absorbed by sea-water in warm climates is small compared

[1] The amount of oxygen absorbed by sea-water depending to a certain extent on the presence of animal life and other accidental causes, the amount of nitrogen may, with greater precision, be assumed to represent the total amount of air — a standard of measurement adopted in the preceeding Memoir.

lidet luftholdige, medens de, der have absorberet sin Luftmængde i de arktiske Egne, maa indeholde meget større Mængder, og man vil derfor netop i de paa Expeditionen udførte Gasanalyser have et fortrinligt Middel til at controllere den forhen opstillede Hypothese, ifølge hvilken enkelte Regioner af det iskolde Dyb skulde være opfyldt af Vandmasser, der ialfald delvis havde atlantisk Oprindelse.

Forat vise Udfaldet af en saadan Control har jeg tegnet Kartet No. III, hvorpaa efter samme Princip som det ved Tegning af Kartet No. II befulgte findes afsat de i Dybet fundne Kvælstofmængder udtrykte i CC. pr. Litre reducerede til 0° og 760^{mm} Tryk, ligesom der ogsaa ved Siden af disse Tal findes opført den Temperatur, hvorved Søvandet absorberer denne Kvælstofmængde, beregnet til nærmeste hel Grad efter den af de tidligere bskrevne Forsøg udledede Formel

$$N = 14.4 - 0.23t.$$

Det siger sig selv, at disse Temperaturer ikke kunne gjøre Fordring paa nogen stor Grad af Nøiagtighed, da en forholdsvis liden Feil i Kvælstofbestemmelsen bevirker en meget stor Feil i den deraf beregnede Temperatur. Der findes saaledes flere Observationer, der give Temperaturen — 4°, en Temperatur, der mig bekjendt ikke er observeret i Havet. Dette vil dog ikke forekomme saa urimeligt, naar man tager Hensyn til, at Søvand af —2° ved 780^{mm} Barometerstand absorberer en Kvælstofmængde, der paa det Nærmeste gaar op til, hvad der i Ydertilfældene er fundet.

Farvelægningen er her foretagen saaledes, at de Strøg, hvor Kvælstofmængden er funden at være 14.4 CC. eller derover, ere betegnede med blaa Farve, de Strøg, hvor Kvælstofmængden ligger mellem 14.4 og 12.5 CC., med en svag rød Farve, medens et mindre Parti, hvor Kvælstofmængden er funden at ligge under 12.5 CC., er betegnet med en noget kraftigere rød Farve. Betydningen af disse Farver bliver ligesom i Kartet No. II den, at de røde Farver bedække de Strækninger, hvor Vandet i mere eller mindre Grad besidder atlantisk Karakter, medens den blaa Farve tilhører de Vandmasser, der have absorberet sin Kvælstofmængde ved en Temperatur af under 0°, og som altsaa nærmest synes at hidrøre fra de arktiske Egne.

Ved at sammenligne Kartene No. II og III vil man strax se, at Farvelægningen i disse i alt Væsentligt viser en særdeles stor Overensstemmelse, som paa mange Puncter endog nærmer sig til Congruents, om man end ved nærmere Betragtning vil finde, at disse Ligheder ikke gaa igjen i alle Detailler, hvad man heller ikke paa nogen Maade kunde vente. Grændserne bliver nemlig paa Kartet No. III paa Grund af Observationernes Faatallighed meget vanskelige at bestemme, ja der findes endog her paa omkring den 65de Breddegrad et større Strøg, hvorom man intet med Bestemthed kan slutte, da der under Analysen tabtes en mindre Del af de Luftprøver, der vare bestemte til at udfylde dette Hul, saaledes at den samlede Luftmængde desværre ikke kunde maales. Desuden ere ogsaa Observationsfeilene baade for Salt- og Kvælstofbestemmel-

with that absorbed in the Arctic regions, wherefore the analyses of gas performed on the Expedition furnish an excellent means of testing the value of the hypothesis according to which certain sections of the cold area are assumed to be made up of water part of which at least would seem to be of Atlantic origin.

To show the result of such a test, I have annexed a third Plate (drawn on the same principle as Pl. II), in which are given the different amounts of nitrogen present in deep water, expressed in c.centim. per litre, reduced to 0° and a pressure of 760^{mm}. Along with these figures will be found, too, the temperature at which sea-water absorbs such an amount of nitrogen, computed, in whole degrees, by means of the formula deduced from the observations previously described, viz: —

$$N = 14.4 - 0.23t.$$

These temperatures cannot of course pretend to any high degree of accuracy, a comparatively small error in a nitrogen-determination involving a very considerable error in the temperature. Thus, for instance, several of the observations indicate — 4°, a temperature which, so far as I am aware, was not anywhere observed in the sea. This, however, will not appear so strange, if regard be had to the fact, that sea-water of — 2°, at a pressure corresponding to 780^{mm}, absorbs an amount of nitrogen which agrees very closely with the highest found on the Expedition.

The sections in this Plate are coloured as follows: those in which the amount of nitrogen was found to equal or to exceed 14.4^{cc}, blue; those in which it ranged from 14.4 to 12.5^{cc}, light red; a somewhat deeper red serves to indicate a small tract in which the amount of nitrogen did not reach 12.5. Moreover, as in Plate II, the red colour indicates water more or less distinguished by Atlantic characteristics; the blue, water in which the nitrogen was absorbed at a temperature below 0°, and which, therefore, would seem to have derived its origin from some part of the Polar Seas.

A comparison of Plates II and III will at once show considerable agreement in the distribution of colour, many of the sections almost coinciding; though, on closer inspection this approach to congruity is not found to characterise all details, which indeed there was no reason to expect. In Pl. III, the limits proved exceedingly difficult to define, owing to the limited number of observations; nay, respecting an extensive tract near the 65th parallel of latitude nothing definite can be inferred, part of several samples of air, the analysis of which would have served to fill up the blank, having been unfortunately lost, and the total amount of air could not, therefore, be measured. Besides, the errors of observation both in the salt and the nitrogen determinations, are so considerable, when compared with the minute differences in amount, that, in some

sernes Vedkommende af saadan Størrelse, at de i Sammenligning med de smaa Differentser, som det her gjælder at paavise, lettelig paa sine Steder kunne gjøre sig gjældende og frembringe Uoverensstemmelser, hvor de i Tilfælde af absolut nøiagtige Observationer ikke vilde findes.

Hvilken Vægt man nu end vil tillægge disse faa Forskjelligheder mellem de to Karter, saa meget er dog sikkert, at de kun optræde som Undtagelser, medens den langt stærkere fremtrædende Regel er Overensstemmelser af saadan Art, at de ikke uden videre kunne tilskrives Tilfældigheder. Der existerer uimodsigeligt en paa mange Puncter næsten til Proportionalitet grændsende lovmæssig Forbindelse mellem Saltgehalten og Kvælstofmængderne, som muligens ikke turde lade sig forklare paa anden Maade end netop gjennem den før omtalte Hypothese, som saaledes maa ansees for at indeholde ialfald en stor Del Sandhed, idet den samtidig bestyrkes af to af hinanden fuldstændig uafhængige, uensartede Observationsrækker, der i alt Væsentligt give det samme Resultat.

Den, som det synes, største Vanskelighed ved denne Hypothese bestaar i at forklare, hvorledes det i de store Dyb flydende atlantiske Vand skulde have antaget en saa lav Temperatur, som det ifølge Observationerne viser sig at besidde. Dette turde dog maaske ikke synes saa urimeligt, naar man betænker, at den varme, søndenfra kommende Atlanterhavsstrøm ved at flyde henover det underliggende meget kolde Vand paa de nærmest til dette grændsende Lag maa blive udsat for en meget stærk Afkjøling nedenfra, og at det først gjennem en saadan Afkjøling til omkring 0° opnaar den høie specifiske Vægt, der er den nødvendige Betingelse for, at det skal kunne synke tilbunds. Det atlantiske Vand har altsaa, allerede førend det begynder at synke, antaget en meget lav Temperatur og vil desforuden under selve Synkningen, idet det da kanske i et meget langt Tidsrum befinder sig paa alle Sider omgivet af polart Vand, end yderligere blive Gjenstand for Afkjøling, førend det naar Bunden. Det fremgaar forøvrigt ogsaa af de endnu ikke offentliggjorte Temperaturobservationer, som jeg desuagtet ved Velvillie af Professor Mohn har faaet Anledning til at gjøre mig bekjendt med, at Temperaturen i de store Dyb paa de med rød Farve betegnede Partier er noget høiere end der, hvor Kartet er farvet blaat, saaledes at i Virkeligheden ogsaa Temperaturforholdene tale for den opstillede Hypothese.

Det vilde dog være paa urette Sted paa dette Stadium at forsøge udredet alle Vanskeligheder, saalænge de paa Expeditionen udførte talrige Temperaturbestemmelser endnu ikke ere forelagte Offentligheden, da man alene ved at tage tilbørligt Hensyn til det hele foreliggende Materiale af Observationer vil kunne vente at faa det bedst mulige Indblik i de mere indviklede Spørgsmaal om Strømforholdene. Det er dog meget sandsynligt, at man senerehen ved at combinere alle Data vil kunne kaste Lys over meget, som nu maa synes dunkelt.

Uheldigvis var det ved Expeditionens Udreise ikke muligt at forudse, at de chemiske Observationer skulde kunne føre til Slutninger af saadan Art som de her paa-

of the computations, they might easily affect the result, and give rise to discrepancies which, with perfectly accurate observations, there would be no fear of.

Whatever weight may be attached to these differences, they must unquestionably be regarded as exceptional; the rule is agreement, and of a character precluding the possibility of ascribing it to chance. Many of the observations prove incontestibly the existence of a definite, well nigh proportional connexion between the amount of salt and that of nitrogen, a connexion difficult, perhaps, to explain without having recourse to the aforesaid hypothesis, which cannot but come near the truth, confirmed as it is by two widely different series of observations, leading, each independently of the other, in all essential points, to the same result.

The greatest apparent difficulty involved in this hypothesis consists in explaining the low temperature of the Atlantic water in the deeper strata. We must, however, bear in mind that the warm Atlantic current, in flowing over the cold water of the lower strata, is necessarily made to part with a very considerable amount of heat; and that the high specific gravity, without which it could not sink to the bottom, involves a temperature of about 0°. Hence, the Atlantic water will have acquired a very low temperature before beginning to sink, and moreover, being surrounded during its downward passage, possibly for a considerable period, by Polar water, give off a further amount of heat ere it reaches the bottom. For the rest, it appears from the independent series of temperature observations, not yet in print, with which Professor Mohn has kindly made me acquainted, that the temperature at great depths in the sections coloured red in the Plate, is somewhat higher than in those coloured blue; and hence the hypothesis adopted here derives additional support from the variation in temperature.

Meanwhile, it would be premature to attempt disposing of all difficulties, till the numerous temperature determinations performed on the Expedition shall have been made public, since to elucidate fully the more intricate questions connected with ocean currents, the whole stock of materials must be dealt with. We may however venture to hope, that, at a later stage of this interesting inquiry, a general combination of data will throw light upon much that is at present involved in obscurity.

Unfortunately, it was not possible to foresee on the departure of the Expedition, that such inferences as those here pointed out would be drawn from the chemical ob

pegede, og det er derfor helt naturligt, naar Undersøgelserne ikke i Henseende til Studiet af tidligere ukjendte Eiendommeligheder ved Havet kunde føre til saa fyldige Resultater, som ønskeligt kunde være. Men om end disse Undersøgelser paa Grund heraf nærmest faa Karakteren af forberedende Arbeider, saa vil det dog, som jeg haaber, indrømmes, at de desuagtet kunne have sine maaske ikke uvigtige Følger, idet de vise, at man gjennem de chemiske Observationer, der tidligere i Sammenligning med Temperatur- og Dybdebestemmelser har spillet en mindre fremtrædende Rolle ved Studiet af Havets Physik, vil kunne skaffe Oplysninger om mærkelige Forholde i Havet, som man ad anden Vei vanskelig skulde falde paa at søge opklarede. Man vil ved Hjælp af de her erholdte Resultater med Lethed i Fremtiden kunne udkaste en detailleret Plan for en fornyet Undersøgelse af det norske Hav, der i mine Øine stiller sig som særdeles ønskelig, da man ved at gjøre et hidindtil ukjendt Hav til Gjenstand for Bearbeidelse vanskelig turde gjøre Regning paa at træffe et, der i Henseende til Studiet af Strømforholdene er saa instructivt som det norske Hav.

Ved saadanne fremtidige Undersøgelser kunne de paa den norske Expedition benyttede Arbeidsmethoder ikke i alle Retninger blive optagne i uforandret Form, og det vil derfor ikke være ubeføiet til Slutning med faa Ord at paapege de Mangler, der klæbe ved disse.

De til Saltbestemmelserne tidligere benyttede Methoder, ifølge hvilke alle herhen hørende Observationer anstilles ombord, bør utvivlsomt for Fremtiden ikke komme til Anvendelse, da man ad den Vei tiltrods for al anvendt Møie ikke vil kunne opnaa den Nøiagtighed, som tiltrænges for med ønskelig Sikkerhed at kunne paavise de i Havet forekommende ofte meget smaa Differentser. Paa den norske Expedition blev denne Fremgangsmaade benyttet, fordi man med ældre Iagttageres Udtalelser for Øie maatte befrygte, at Søvand ikke lod sig opbevare i længere Tidsrum uden at undergaa forskjellige Forandringer, en Frygt, der imidlertid efter min Erfaring kun forsaavidt er begrundet, som man til Opbevaring af Vandet benytter Kar, der ere forsynede med Korkeprop. Jeg har nemlig undersøgt flere Vandprøver, der have været opbevarede paa denne Maade i omkring 2 Aar og fundet, at de alle uden Undtagelse have undergaaet Forandringer af saadan Art, at man turde være berettiget til at anse dem uskikkede til Egenvægtsbestemmelse, hvorimod jeg hos Vandprøver, der i lignende Tidsrum havde henstaaet paa Flasker forsynede med isleben Glasprop, ikke kunde opdage nogensomhelst Eiendommeligheder, der kunde adskille dem fra friskt øste Vandprøver. Ved denne Opbevaringsmaade risikerer man dog ganske sikkert Fordunstning af en Del af Vandet, og man maa derfor beskytte sig mod denne Feilkilde ved at hjemføre det til Saltbestemmelser bestemte Vand paa tilsmeltede Glasrør.

I de saaledes conserverede Vandprøver vil man senerehen efter Hjemkomsten kunne bestemme Egenvægten ved Sprengels Pyknometer og Chlorgehalten ved Hjælp af Veiningsanalyser med saadan Skarphed, som man ved Arbeide

servations, and hence the results of the work done, embracing as it did the investigation of phenomena unknown before, were naturally less comprehensive than might otherwise have been attained. But, though such labours must to a certain extent, be regarded as preliminary, they will, I trust, prove of considerable importance, showing as they do, that chemical observations, which, as compared with determinations of temperature and depth, previously held quite a subordinate rank among the means employed for studying the physical conditions of the ocean, will serve to throw light upon many remarkable phenomena, that without such data would be extremely difficult to explain. On the basis of the results here set forth, a detailed plan might be easily laid down for the further exploration of the Norwegian Sea, — in my opinion a most desirable undertaking, since of ocean tracts as yet unknown, there are probably few that, in regard to the study of ocean currents, would so well repay investigation as that section of the North-Atlantic.

As several of the methods of investigation practised on the Norwegian Expedition, will not admit of being adopted on future occasions in a wholly unmodified form, it will not be out of place in conclusion briefly to point out their defects.

The methods previously devised for determining the amount of salt in sea-water, by which all observations with this object in view were taken on board, should unquestionably cease to be adopted, since they will not suffice, with the greasest care even, to attain the high degree of accuracy requisite for detecting such minute differences as are frequently found to occur. These defective modes of operation were, however, adopted on the Norwegian Expedition, there being reason to believe from the statements of earlier observers, that sea-water could not be preserved for any length of time without undergoing chemical change, a supposition which, so far as my experience goes, is confirmed only in the event of its being kept in *corked* vessels. I have examined, for instance, various samples of sea-water that had been preserved for about 2 years in corked bottles, and found all without exception to have undergone a change sufficient to render them unfit for specific gravity determinations; whereas, on the other hand, sea-water which had been allowed to stand over for the same space of time in bottles furnished with ground glass stoppers, was not to be distinguished from freshly drawn samples. There is, however, a risk of loss from evaporation, the stoppers being seldom, if ever, tight-fitting; and to guard against this source of error, the water for salt-determinations must be brought home in hermetically sealed glass tubes.

With water thus preserved, the specific gravity may be determined by means of Sprengel's pycnometer, and the amount of chlorine by weighing, on the return of the Expedition, far more accurately than would be possible on

ombord ikke i fjerneste Maade vil kunne gjøre Regning paa at opnaa, hvorhos man tillige vil have den Fordel at kunne benytte directe Saltbestemmelser som Controlmiddel.

Mod de paa Expeditionen udførte Luftbestemmelser vil ikke kunne gjøres nogen væsentlig Indvending, med mindre man skulde anke over, at de benyttede Vandprøver ere optagne ved Hjælp af Apparater, der ikke vare omgivne med slette Varmeledere, saaledes at de ved Ankomsten til Overfladen vilde have havt Anledning til at antage en i Forhold til sin Luftmængde noget for høi Temperatur. Denne Feilkilde kan dog ikke antages at have faaet nogen væsentlig Indflydelse i et Hav som det her undersøgte, hvor kun et meget tyndt Lag nærmest Overfladen besidder en Temperatur af over 5°, især da Vand, der kun er svagt overmættet med Luft, meget langsomt giver Slip paa den overskydende Del.

Det ved Udkogningen benyttede, af Jacobsen beskrevne Apparat er i alt Væsentligt fundet særdeles bekvemt, kun vilde det maaske være hensigtsmæssigt at give Luftopsamlingsrøret en noget forandret Form, hvorved man lettelig vilde undgaa den Vanskelighed, hvormed det nu er forbundet at overfylde Luftmængden i Eudiometret uden Tab.

Ovenstaaende Afhandlinger ere indsendte til Redactionscomiteen for den norske Nordhavsexpeditions Generalberetning, No. I og II i April 1879 og No. III i December samme Aar.

De i disse 3 Afhandlinger beskrevne Observationer ere, forsaavidt de ikke ere udførte ombord, anstillede i Professor Waages Afdeling af Universitetets chemiske Laboratorium i Christiania.

Sluttelig benytter jeg Anledningen til at udtale min Tak til D'Hrr Professorerne Waage og Mohn for den Bistand, de under mit Arbeide med disse Gjenstande paa flere Puncter har ydet mig.

board; moreover, there is the additional advantage of being able to test the results by direct salt-determinations.

As regards the air-determinations performed on the Expedition, their general accuracy can hardly be impugned. True, the apparatus with which the samples of water were collected not having been surrounded by a non-conducting medium, they may possibly in their passage to the surface have assumed a temperature somewhat too high as compared with the amount of air contained in them; but the error arising from this source cannot have exerted any material influence, since the tract of ocean investigated has but a thin stratum of water in which the temperature rises above 5°; besides, water slightly surcharged with air is found to part very slowly with the surplus portion.

The boiling-apparatus devised by Jacobsen proved very convenient; possibly, however, the tube for collecting air might be given a somewhat different form, to obviate the difficulty now experienced in transferring the air to the eudiometer without loss.

These Memoirs were sent in to the Editorial Committee for the Norwegian North-Atlantic Expedition as follows: — Nos. I and II in April 1879 and No. III in December.

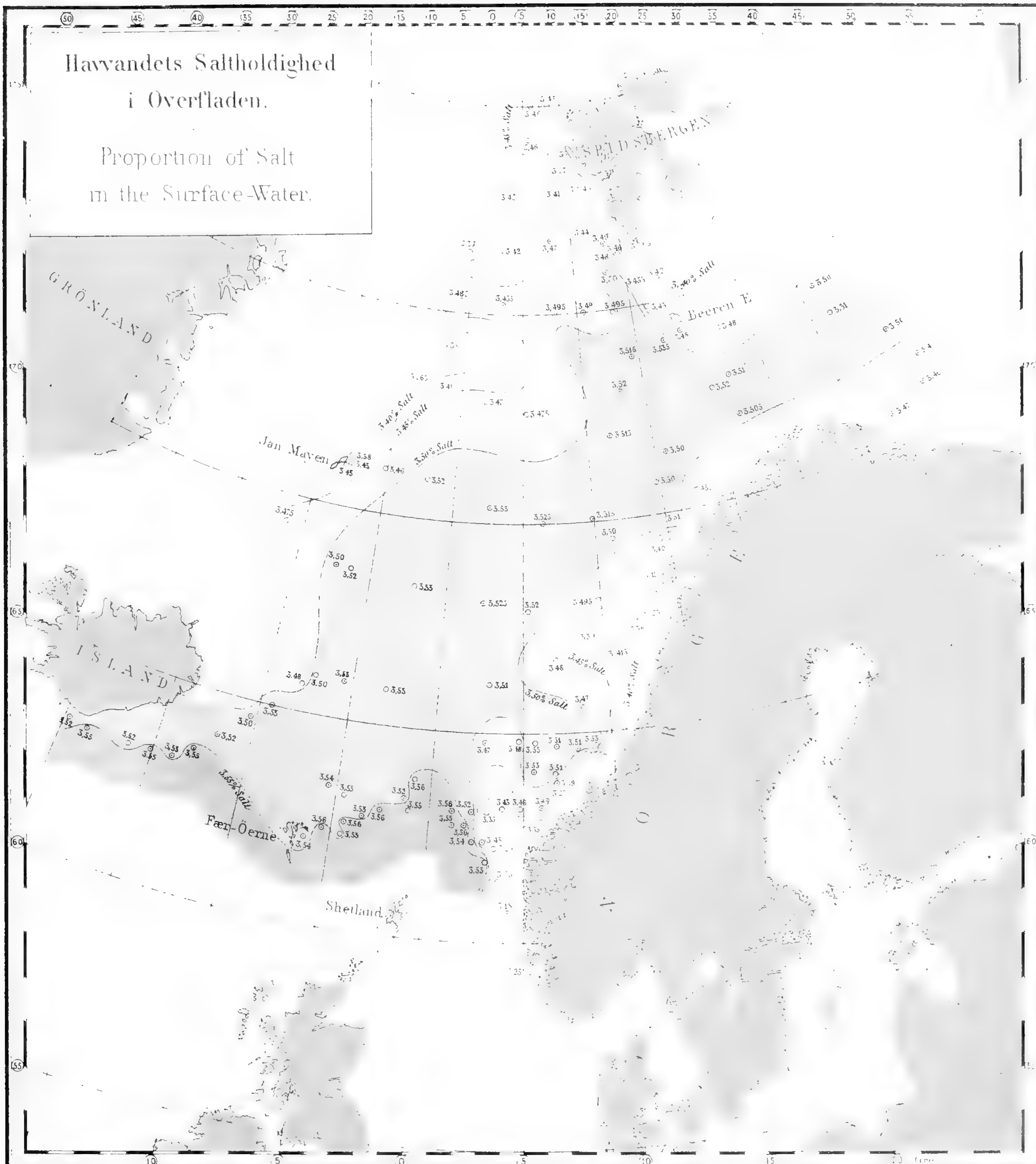
The observations set forth in the foregoing Memoirs were, when not taken on board, instituted in Professor Waage's department of the Chemical Laboratory of the University of Christiania.

In conclusion, I must not omit to thank Professors Waage and Mohn for the assistance they kindly rendered me, in certain respects, when engaged on the investigation of the subjects treated of in these papers.

Errata.

Page 3, line 26, from top of page, *for* '35.4 to 32.4 — 33.6 per cent, being' *read* '35.4 to 32.4, 33.6 per cent being.'
- 9, line 20, from top of page, *for* 'the extent to which the results based on that hypothesis,' etc. *read* 'the slight extent to which Jacobsen's results,' etc.
- 28, line 22, from top of page, *for* 'soda was added, and the whole compound' *read* 'carbonate of soda was added, and the whole mixture.'
- 38, line 3, from foot of page, *for* 'soda' *read* 'carbonate of soda.'
- 39, line 13, from foot of page, *for* 'soda' *read* 'carbonate of soda.'

Translated into English by **John Hazeland**.


Havvandets Saltholdighed
i Overfladen.
Proportion of Salt
in the Surface-Water.
GRÖNLAND
SPITSBERGEN
Beeren E.
Jan Mayen
ISLAND
Fær-Öerne
Shetland
3,40% Salt
3,45% Salt
3,50% Salt
3,55% Salt


Havvandets Saltholdighed
i de dybere Lag.
Proportion of Salt
in the Deeper Strata.
GRÖNLAND
SPITSBERGEN
Beeren E.
Jan Mayen
ISLAND
Fær-Oerne
Shetland
NORGE

Den geogr. Opmaalings lith. Anstalt Kristiania

DEN NORSKE NORDHAVS-EXPEDITION

1876—1878.

CHEMI.

I. OM SØVANDETS FASTE BESTANDDELE.

II. OM HAVBUNDENS AFLEIRINGER.

AF

LUDVIG SCHMELCK.

MED 1 TRÆSNIT OG 2 KARTER.

CHRISTIANIA.

GRØNDAHL & SØNS BOGTRYKKERI.

1882.

THE NORWEGIAN NORTH-ATLANTIC EXPEDITION

1876—1878.

CHEMISTRY.

I. ON THE SOLID MATTER IN SEA-WATER.

II. ON OCEANIC DEPOSITS.

BY

LUDVIG SCHMELCK.

WITH 1 WOODCUT AND 2 MAPS.

CHRISTIANIA.

PRINTED BY GRØNDAHL & SØN.

1882.

Om Søvandets faste Bestanddele.

Den temmelig rige Literatur, der handler om Søvandsundersøgelser, gaar helt tilbage til Slutningen af det forrige Aarhundrede. De Kemikere, der fra Begyndelsen af tog dette Emne under Behandling, lagde naturligvis først og fremst Vægten paa at bestemme Vandets samlede Saltmængde eller dets tilsvarende Egenvægt i de forskjellige Dele af Oceanet.

De første Undersøgelser i denne Retning førte snart til den Slutning, at Havets Saltholdighed ikke var underkastet andre Forandringer, som ved Datidens analytiske Midler kunde paavises, end slige, der var en nødvendig Følge af særegne forud bekjendte Naturforhold, f. Ex. Fortyndningen i de polare Egne ved store Ismassers Smeltning. Denne Havets Ensartethed med Hensyn til dets samlede Saltgehalt sandsynliggjorde naturligvis ogsaa den Antagelse, at Forholdet mellem dets enkelte Bestanddele var af en lignende uforanderlig Beskaffenhed. Skjønt de første Forsøg paa at bestemme Søsaltets Sammensætning ikke førte til saadanne Resultater, der fra Kemiens nuværende Standpunkt vilde betegnes som overensstemmende, ser vi dog, at allerede Marcet (Phil., trans. 1822) drager den Slutning af sine Søvandsundersøgelser, at der kun er meget liden Variation i Forholdet mellem Kalk, Magnesia, Klor og Svovlsyre i Havvandet. At Havet er en ensartet Blanding, eller at Variationerne i dets Sammensætning kun kan dreie sig om smaa Størrelser, er senere bekræftet ved talrige Undersøgelser, men den største Del af de Analyser, der ere udførte i denne Retning, ere dog — lige indtil den Tid, da Forchhammer offentliggjorde sin Afhandling om Søvandet — temmelig værdiløse, da de ialmindelighed er behæftede med altfor store Feil til at kunne have nogen Betydning fra et nyere Standpunkt betragtet. De talrige og fortrinlige Undersøgelser, Forchhammer har udført for at komme til Klarhed i denne Sag viser tydelig, at man skal arbeide med stor Omhyggelighed, hvis ikke Feilene ved Analysen skal blive større end de smaa Variationer i Havets Sammensætning. Denne udmærkede Forsker har undersøgt 180 Vandprøver fra de forskjellige Dele af Verdenshavet og udført sine Analyser med en Grundighed og Nøiagtig-

On the Solid Matter in Sea-Water.

The first of the numerous works on ocean-water date from the close of the last century; and the branch of the subject which, to the earlier authors, would appear of paramount importance, was naturally the determination of the total amount of salt in sea-water, or the equivalent specific gravity of the latter, in all parts of the globe.

On instituting observations with this object in view, it soon became apparent — to the extent at least for which the limited means of analysis then known sufficed — that the proportion of salt in ocean-water was not subjected to other disturbing influences than such as could be readily traced to physical causes: for instance, dilution, in the Arctic regions, from the melting of enormous masses of ice. And the remarkable uniformity prevailing in the proportion of the total amount of salt, was plainly in favour of the hypothesis, that a like unvarying relation should subsist between the different constituents. The first experiments to determine the nature of sea-water, did not indeed give results that would now be held to exhibit close agreement; and yet Marcet (Phil. trans. 1822) was led to infer, that the variation in sea-water between lime, magnesia, chlorine, and sulphuric acid is relatively very trifling. That the ocean, so to speak, is a homogeneous fluid, or, that the variations exhibited in its composition represent magnitudes comparatively minute, — this view has since been repeatedly confirmed; but the greater part by far of the analyses performed to test it — previous to the date at which Forchhammer published his treatise on ocean-water — are of very questionable value, being most of them beset with errors, which, when viewed in the light of modern science, must be regarded as far too considerable to admit of our attaching any real importance to their results. The series of numerous and most successful experiments instituted by Forchhammer, sufficiently attest the care that is needed to keep the errors of analysis from exceeding in magnitude the inconsiderable variations occurring in the composition of sea-water. That distinguished observer examined no less than 180 samples of sea-water, collected

hed, der giver dem en ganske anden Betydning end de foregaaende.

Imidlertid kan der efter Forchhammers eget Udsagn gjøres nogle Indvendinger med Hensyn til Indsamlingen af disse Vandprøver, der for den største Del blev medbragt af forskjellige Søfarende, hvorved man ikke altid kunde have den nødvendige Garanti for deres omhyggelige Optagelse og Opbevaring. De Feilkilder, der paa denne Maade kunde opstaa, er maaske for en Del Skyld i de Uoverensstemmelser, der hist og her forekommer i Forchhammers Tabeller, hvor den overveiende Del af Tallene kun viser smaa og ialmindelighed let forstaaelige Differentser.

Forat skaffe Vand op fra Dybet har Forchhammer betjent sig af en tilproppet tom Flaske, som firedes ned til det bestemte Dyb, hvorved Vandet trykkede Proppen ind og fyldte Flasken. Ved Opbringelsen bragtes paa Grund af den tiltagende Varme og det aftagende Tryk Proppen atter paa sin Plads i Flaskens Munding. Man kan indse, at denne Fremgangsmaade ikke yder nogen tilstrækkelig Garanti for, at det optagne Vand virkelig stammer fra de bestemte Dybder; og Forchhammer indrømmer ogsaa villig dens Mangelfuldhed. De Dybvandsiagttagelser, Forchhammer paa denne Maade har anstillet, er ogsaa temmelig faatallige og indskrænker sig ialmindelighed til de høiereliggende Vandskikter, saa at man ikke deraf kan drage nogen Slutning med Hensyn til det Vand, der befinder sig i nærmere Berørelse med Havbunden. Der var jo en Mulighed for, at der her kunde gjøre sig andre Kræfter gjældende, f. Ex. Dyrelivet eller Havbundens Beskaffenhed, som kunde frembringe Forandringer i Havets Sammensætning.

Andre Kemikere har vistnok i den senere Tid behandlet dette Emne, og enkelte har ogsaa fundet, at Vandet fra Bunden har en noget anden Sammensætning end Vandet fra Overfladen, men disse Iagttagelser ere dog i flere Retninger saa ufuldstændige, at nøiere Undersøgelser maa være af Interesse.

Da den norske Nordhavsexpedition i Aarene 1876, 1877 og 1878 udgik paa sine forskjellige Togter forat undersøge Havet mellem Norge, Færøerne, Island, Jan Mayen og Spidsbergen i fysisk, zoologisk og kemisk Retning, var den rigelig udrustet med Redskaber til Indsamlingen af det respektive videnskabelige Materiale.

Til Opbevaring af Vandprøver var medtaget omkring 100 med Glasproppe forsynede Flasker (hvoraf de fleste rummede 2, nogle 5 Liter). Prøverne bleve dels tagne fra Overfladen, dels hentede fra Bunden og de mellemliggende Dyb ved Hjælp af en af Hr. Kaptain Wille konstrueret Vandhenter[1]. Ved Optagelsen af Vandet, saavelsom ved

[1] Tegning og Beskrivelse af dette Apparat findes i Tornøe's Afhandling om den i Søvandet opløste Luft.

in different parts of the ocean, performing his analyses with a thoroughness and rigorous precision that entitle them, as scientific results, to a far higher rank than can be claimed for any preceding observations.

Meanwhile, as Forchhammer himself admits, objections may be urged to the mode in which these samples of sea-water were drawn, the greater part having been brought home by seamen; and hence it was not always possible to obtain the necessary assurance, that due care had been taken in collecting and preserving them. To errors that may possibly have arisen from this source, we must, perhaps, partly ascribe the want of agreement met with here and there throughout Forchhammer's Tables, in which the figures generally exhibit but small differences easily accounted for.

To obtain deep-sea water, Forchhammer made use of a corked bottle, which was sunk to a depth at which the water, by reason of its greater pressure, forced in the cork and filled the bottle. On hauling in the line, the increased temperature and diminished pressure brought back the cork to its original position in the neck of the bottle. Now it is obvious, that, with this mode of drawing sea-water, there can be no absolute certainty of the sample obtained originating at the required depth; and Forchhammer readily grants its defectiveness. Indeed, the observations he has instituted with water drawn in this manner are comparatively few, and chiefly confined to the higher of the deep-sea strata; and hence nothing can be inferred from them respecting the water which is in close proximity to the bottom. Possibly, other agencies may be at work there; such, for instance, as depend on the presence of animal life or on the nature of the bottom, and which, in some way or other, might influence the composition of ocean-water.

Other chemists, too, have of late years investigated this subject; and, according to some, water from the bottom does differ slightly in composition from surface-water. Meanwhile, their results are in many respects so defective, that a record of more trustworthy observations, adapted to the present state of chemical science, will, it is believed, be found specially opportune.

The Norwegian North-Atlantic Expedition despatched in the years 1876, 1877, and 1878, for the physical, zoological, and chemical investigation of the tracts of ocean stretching between Norway, the Faröe Islands, Iceland, Jan Mayen, and Spitzbergen, was fitted out with the greatest care, being furnished with every aid and appliance deemed even remotely requisite for the attainment of the end proposed.

Among the chemical desiderata were comprised about 100 phials, with ground glass stoppers (some containing 2, and some 5 litres), in which to preserve samples of sea-water. The samples collected on the Expedition were obtained partly from the surface, partly from intermediate depths, and partly from the bottom, in an instrument[1] de-

[1] This apparatus is figured and described in Tornøe's Memoir on the air in sea-water.

Paafyldningen af Flaskerne, blev der anvendt den største Omhyggelighed, idet disse Operationer enten foregik under Opsigt af Hr. Tornøe, der fra 1877 var ansat som Expeditionens Kemiker, eller af mig, der i det følgende Aar deltog i Expeditionen, da Hr. Tornøe ikke alene kunde overkomme alle de kemiske Arbeider, som vare nødvendige under Reisen. De af os medbragte Vandprøver ere hentede nordenfor den nordlige Polarkreds; de øvrige, der ere tagne søndenfor denne, ere paa samme Vis indsamlede og opbevarede af Hr. Svendsen, der var Expeditionens Kemiker paa dens første Udflugt i 1876.

Alle de Arbeider, der ere udførte ombord, saasom Luftudkogninger, Bestemmelser af Kulsyren, Klormængden og den specifiske Vægt ere senere bearbeidede og diskuterede af min Ven Hr. Tornøe, der har overtaget den fysisk-kemiske Del af Arbeidet, medens det for mig stod tilbage at underkaste de medbragte Vandprøver en kemisk Analyse med Hensyn til de øvrige faste Bestanddele.

Ved disse Undersøgelser har jeg nu sat mig som Formaal at udfinde, hvorvidt Forholdet mellem Søvandets Bestanddele er udsat for saa store Forandringer, at de lader sig paavise ved de nøiagtigste analytiske Methoder, og om man af de fundne Tal kan uddrage nogen Regel med Hensyn til de mulige Forskjelligheder i Søvandets Sammensætning. I dette Øiemed har jeg udelukkende lagt Vægten paa de af Havets Bestanddele, der for det første lader sig bestemme med den største Lethed og Sikkerhed, og for det andet — efter al Erfaring og Sandsynlighed — maa være de Stoffer, som fortrinsvis kan paavirkes af andre i Havet forekommende Kræfter. Med dette Formaal for Øiet maa man nærmest henvende sin Opmærksomhed paa Kalk, Magnesia, Svovlsyre og Klor. Natron, Kali og de i mindre Mængde forekommende Baser og Syrer har med Hensyn til det foreliggende Spørgsmaal liden eller ingen Interesse, da de ikke kan bestemmes med den nødvendige Nøiagtighed. Hellerikke kan man for Alkaliernes Vedkommende tænke sig, at de skulde være synderlig afhængige af fremmede Paavirkninger, uden forsaavidt som en Variation i Klornatrummængden, der jo udgjør den overveiende Del af Havsaltet, vilde være ensbetydende med en tilsvarende Forandring i Vandets Egenvægt. Da der imidlertid er stor Uoverensstemmelse mellem de Tal, der af forskjellige Kemikere er fundne for Kalimængden i Søvandet, har jeg for Sammenlignings Skyld bestemt denne Bestanddel i nogle Vandprøver fra forskjellige Punkter af Havet.

Blandt de Salte, der forekomme i mindre Mængde i Søvandet, har især deleshed den kulsure Kalk været Gjenstand for Kemikernes Opmærksomhed. Mange har bestemt denne Forbindelse ved at koge en vis Portion af Søvandet i længere Tid — under stadig Erstatning af det fordampede Vand — og derpaa veie det udskilte Bundfald. Ved at analysere dette har jeg imidlertid ikke fundet Spor af

vised by Captain Wille, R. N. When drawing the water and filling the phials, the greatest care was taken, these simple but delicate operations having been invariably performed in the presence either of Mr. Tornøe (since 1877 chemist to the Expedition) or of myself, who the following year went out as assistant-chemist, Mr. Tornøe not being equal to all the chemical work that had to be done on the last cruise. The samples of sea-water brought home by us on the return of the Expedition, were all collected north of the Arctic circle; those from the first cruise, in 1876, having been similarly obtained and preserved by Mr. Svendsen, the gentleman originally appointed chemist to the Expedition.

All chemical work done on board, viz. determinations of air, carbonic acid, chlorine, and specific gravity, has been since critically reviewed and tested by my friend Mr. Tornøe, who undertook to work up the physico-chemical details, while I have analysed the various samples of sea-water with a view to determine their solid constituents.

My object with this investigation, has been to ascertain, if possible, whether the relation subsisting between the component parts of sea-water varies sufficiently to admit of determining its fluctuations by the most exact analytical methods; and whether, in that case, it were not possible from the results attained to deduce some definite rule regulating such assumptive differences in the composition of sea-water. To this end, I have exclusively laid weight on those constituents of ocean-water which, first, admit of being determined with the greatest accuracy and facility, and which, secondly, — as is indicated alike by experience and probability, — must be the substances specially acted upon by the forces operating in sea-water. And those substances are chiefly lime, magnesia, sulphuric acid, and chlorine. Soda, potash, and the bases and acids occurring in quantities comparatively small, have, as affecting this question, little or no interest, since they cannot be determined with sufficient exactness. Nor is it likely that the proportion of alkalies is dependent in any considerable degree upon extraneous influence, save inasmuch as a variation in the amount of chloride of sodium, which constitutes, we know, by far the greater part of the salts in sea-water, would imply a corresponding change in the specific gravity of the water. Meanwhile, as the figures computed by divers chemists for the proportion of potash in sea-water, exhibit a remarkable want of agreement, I have determined that substance in several of the samples of water collected from different parts of the ocean.

Among the salts which sea-water contains in small quantities only, carbonate of lime is that which has most attracted the attention of chemists. Its relative proportion has been repeatedly determined, by boiling for a considerable time a given quantity of sea-water, — the loss from evaporation being supplied as it arises, — and then weighing the precipitate. On analysing this deposit, I have

Kalk[1]. Dette Bundfald viste sig at bestaa af Magnesia foruden en Smule Jern og Fosforsyre og neppe mærkelige Spor af Kulsyre. Inddamper man derimod en Liter Søvand til dens halve Volum, saa danner der sig et Bundfald, som bestaar af kulsur Kalk og Gibs og kun indeholder smaa Mængder Magnesia. Men hvorvidt den kulsure Kalk, som i dette Tilfælde udskiller sig, virkelig fra Begyndelsen af har været oplost som saadan i Søvandet, kan naturligvis ikke afgjøres ved dette Forsog. Tvertimod synes det med megen Rimelighed at fremgaa af Hr. Tornøe's Undersogelser over Kulsyren i Søvandet, at denne fortrinsvis maa være bundet til Natron som dobbelt kulsurt Salt.

Ved videre Inddampning af Søvandet udskilles Gips og Klornatrium. Endnu efterat Hovedmassen af Kogsaltet har afsat sig, indeholder Moderluden alle de Kali- og Magnesiasalte, der fra Begyndelsen af har været tilstede i Vandet. I en saadan Moderlud fra 20 Liter Søvand lykkedes det mig at paavise Jod efter den af Koetstorfer[2] angivne Methode. Ved Afkjøling under 0° udskilte den Krystaller af svovlsurt Natron, ved hoiere Temperatur svovlsur Magnesia.

Forchhammer angiver i sin Afhandling om Søvandet, at han flere Gange har fundet Svovlvandstof i de hjemsendte Prøver. Han tilføier imidlertid, at denne Forbindelse muligens kan være opstaaet ved en mindre omhyggelig Rensning af Flaskerne; men i enkelte Tilfælde føler han sig dog forvisset om, at den maa have dannet sig af Søvandets egne Bestanddele. Jeg har aldrig kunnet opdage den karakteristiske Lugt af denne Gas ved Aabningen af de fra Expeditionen medbragte Vandprøver. Selv nogle af disse, der undtagelsesvis vare blevne opbevarede i almindelige, med Korkpropper forsynede, Flasker og først aabnedes efter et Par Aars Forløb, befandtes at være fuldkommen lugtfrie.

Efter Forchhammer's Mening skulde Svovlvandstoffet have dannet sig ved Oxydation af de organiske Stoffe paa de svovlsure Saltes Bekostning. Forat bestemme Søvandets organiske Bestanddele benyttede Forchhammer Kogning med Kamæleon, og indførte derved en Methode, der som bekjendt senere har faaet en udstrakt Anvendelse med Hensyn til Drikkevand.

Han tilsatte Søvandet saameget af en bekjendt Opløsning af overmangansur Kali, at det efter et Opkog og Henstand i 12 Timer beholdt en rødlig Farve. Den i Overskud tilsatte Kamæleon fandtes ved at bestemme den Mængde af denne, der var nødvendig forat frembringe samme Farve i det samme Volumen rent Vand. Ved at anvende denne Methode har jeg fundet, at 100 Kc. Søvand ialmindelighed affarver 0,0005 Gr. overmangansur Kali, hvad der omtrent skulde svare til 0,0025 pCt. organiske

[1] Sammenlign Tornøe's Afhandling om Kulsyren i Søvandet.

[2] Zeitschrift für anal. Chemie, 1878, S. 305.

failed however to detect the slightest trace of lime.[1] The said deposit was found to consist of magnesia, along with a little iron and phosphoric acid, and hardly appreciable traces of carbonic acid. If, on the other hand, a litre of sea-water be reduced by boiling to half its volume, the precipitate will consist of carbonate of lime and gypsum, the proportion of magnesia being comparatively small. But whether the carbonate of lime precipitated in this case was originally present as such in the water, is a question which cannot be decided by this experiment. Judging, however, from the results of Mr. Tornøe's observations on the carbonic acid present in sea-water, that gas may with good reason be inferred to occur chiefly in combination with soda as a bicarbonate.

On further evaporation of the sea-water, gypsum and chloride of sodium are deposited; and even after the bulk of the chloride of sodium has been precipitated, the mother-liquor contains all the salts of potash and magnesia originally present in the water. In mother-liquor of this description, obtained from 20 litres of sea-water, I succeeded in detecting iodine, by the process described by Koetstorfer.[2] On reducing the temperature, sulphate of soda was deposited; on raising it, sulphate of magnesia.

In the treatise on ocean-water, Forchhammer records his having frequently met with hydrosulphuric acid in the samples of sea-water sent him; and this compound may, he thinks, in most cases, be traced to impurities in the bottles; though in some he feels convinced it had formed from the constituent parts of the sea-water itself. I did not however in any case detect the fœtid smell characteristic of that gas, when opening the numerous phials brought home with the Expedition. Certain of the samples even exceptionally preserved in common corked bottles, and allowed to stand over for the space of two years, proved to be quite inodorous.

According to Forchhammer, hydrosulphuric acid is formed by the oxidation of organic matter, at the cost of the sulphates. In order to determine the organic elements of sea-water, Forchhammer boiled the latter with permanganate of potash, thus devising a process which has since been extensively adopted for the determination of organic matter in drinking-water.

He added to the sea-water a solution of permanganate of potash, of known strength, sufficient to give it, on being boiled and suffered to stand over for the space of 12 hours, a reddish colour. The excess of permanganate of potash was found by determining the proportion of that substance necessary to produce the same colour in an equal volume of pure water. Adopting this method, I found that 100^{cc} generally sufficed to discolour 0.0005^{gr} of permanganate of potash, which nearly corresponds to 0.0025^{gr}

[1] *Vide* Tornøe's Memoir "On the Carbonic Acid in Sea-Water."

[2] Zeitschrift für anal. Chemie, 1878, S. 305.

Stoffe. Dette er mindre end Halvdelen af, hvad Forchhammer har fundet som Middeltal for Havets organiske Bestanddele, men stemmer ganske godt overens med nogle Bestemmelser, der i den senere Tid er udført af Professor Almén[1] i endel Vandprøver fra Omegnen af Spidsbergen. Almén anvender hertil den samme Methode som ved Drikkevand, idet han tilsætter Søvandet Svovlsyre og ved gjentagne Kogninger med Kamæleon oxyderer de organiske Stoffe. Forat forhindre den skadelige Virkning af Klormetallerne fortynder han det iforveien med destilleret Vand. Paa denne Maade finder han, at 100 Kc. Ishavsvand indeholder 0,0018—0,0038 Gr. organiske Substantser. Nordsøen, Skagerak og Kattegat skulde efter hans Undersøgelser indeholde en større Mængde organiske Bestanddele, men dog ikke saameget som det ferske Vand fra Floder og Indsøer, hvilket viser, at Søvandet ikke fremfor dette er begavet med nogen særegen reducerende Evne. Paa mange af de fra Expeditionen medbragte Flasker havde der i Tidens Løb udskilt sig et ubetydeligt fnokket Bundfald af organiske Stoffe, der under Mikroskopet viste sig at indeholde Diatomeer. Filtratet forholdt sig imidlertid ganske ordinært ligeoverfor den overmangansure Kali.

Til Bestemmelsen af Kalk, Magnesia og Svovlsyre i Havvandet har jeg betjent mig af de almindelige velbekjendte Methoder; men de forberedende Undersøgelser, jeg har gjort forat forsikre mig om Paalideligheden af disse, har vist mig, at de ikke altid giver saa nøiagtige og overensstemmende Resultater, som ere nødvendige for et Arbeide som det foreliggende, hvis man ikke i enkelte Retninger tager nogle Forsigtighedsregler, der ere altfor løst omtalte i de analytiske Haandbøger. Jeg vil derfor i det følgende gaa lidt nærmere ind paa de Fremgangsmaader, jeg har brugt forat erholde de nøiagtigste Bestemmelser.

Kalk og Magnesia.

Til disse Bestemmelser afveiedes $^1/_4$ Liter Søvand. Efterat Magnesiaen ved Tilsætning af omtrent 25 Kc. koncentreret Saltsyre og derpaa følgende Neutralisation med koncentreret Ammoniakopløsning indtil et ubetydeligt Overskud var forhindret fra at falde ud, blev Kalken i Kulden bundfældt med et Overskud af oxalsur Ammoniak. Efter en Nats Henstand frafiltreredes Bundfaldet, opløstes i varm Saltsyre og udfældtes atter i Koghede med Ammoniak og nogle Draaber oxalsur Ammoniak. Efter 12 Timers Forløb blev Bundfaldet bragt paa Filtrum og bestemt som Ætskalk. Tilstedeværelsen af Klornatrium har ingen skadelig Indflydelse paa Kalkbestemmelsen, men synes tvertimod at bidrage til en smuk krystallinsk Udfældning af den oxalsure Kalk. Følgende Kontrolbestemmelser viser Analysernes Paalidelighed:

[1] Svenska läkaresälskapets nya handlingar. Ser. II, del III, Stockholm 1871.

organic matter. This is less indeed than half the proportion Forchhammer gives as the mean for the organic elements of ocean-water; it agrees, however, pretty closely with certain determinations performed some time since by Professor Almén[1] with samples of sea-water collected in the region of Spitzbergen. Almén resorts to the method adopted for drinking-water, mixing sulphuric acid with the water, in which, after repeated boiling with permanganate of potash, the organic matter will be oxidized. To counteract the injurious effect of the chlorides, he dilutes the samples beforehand with distilled water. In this manner he finds that 100^{cc} of Arctic sea-water contain from 0,0018^{gr} to 0,0038^{gr} of organic matter. According to his observations, the proportion is somewhat greater in the North Sea, the Skagerak, and the Cattegat, though not equal to that in the water of rivers and lakes, which shows that sea-water, compared to the latter, cannot be possessed of any special reductive property. In some of the phials brought home with the Expedition, had formed a thin precipitate of organic matter, which, when viewed under a microscope was found to contain Diatoms. The filtered solution, however, behaved as usual when treated with permanganate of potash.

For determining the potash, magnesia, and sulphuric acid in ocean-water, I have adopted the ordinary, well-known methods; but the series of preliminary experiments which I instituted with a view to test their trustworthiness, has convinced me that they do not always give results sufficiently accurate and congruous to warrant their adoption here, unless indeed accompanied by certain precautions too briefly dismissed in analytical class-books. I shall therefore in the context dwell more at large on the several modes of operation by which I have sought to obtain the most accurate determinations.

Lime and Magnesia.

For determining these substances, a quarter of a litre of sea-water was first weighed. After guarding against the precipitation of the magnesia, by adding about 25^{cc} of concentrated hydrochloric acid, and then neutralising with a concentrated solution of ammonia, in slight surplus, the lime was precipitated cold, by means of oxalate of ammonia in excess. Next morning the precipitate was filtered off, dissolved in warm hydrochloric acid, and again precipitated, at the boiling point, with ammonia and a few drops of oxalate of ammonia. After 12 hours, the solution was filtered, and the precipitate weighed, as caustic lime. The presence of chloride of sodium has no disturbing effect on the lime-determinations; nay, it apparently contributes towards the beautiful crystalline precipitation of the oxalate of lime. The following test-determinations vouch for the accuracy of the analyses: —

[1] Svenska läkaresälskapets nya handlingar. Ser. II, del III, Stockholm 1871.

I No.	1	fandtes	0.0595	og	0.0602	pCt.	CaO.
I „	11	—	0.0580	„	0.0590	„	„
I „	26	—	0.0590	„	0.0596	„	„
I „	33	—	0.0585	„	0.0595	„	„
I „	34	—	0.0590	„	0.0593	„	„
I „	35	—	0.0585	„	0.0588	„	„
I „	36	—	0.0577	„	0.0579	„	„
I „	49	—	0.0578	„	0.0582	„	„
I „	50	—	0.0583	„	0.0588	„	„

Den største Differents mellem Bestemmelserne i et og samme Vand er altsaa 0.001 pCt.

Til Bestemmelsen af Magnesia inddampedes de to Filtrater fra Kalkfældingerne i en Platinskaal til omtrent 150 CC. og bundfældtes derpaa med fosforsurt Natron og en saa stor Mængde koncentreret Ammoniakopløsning, at denne kom til at udgjøre omtrent $^1/_3$ af Vædskens Volum. Iagttager man ikke den Forsigtighedsregel at tilsætte et saadant Overskud af Ammoniak, vil man let faa uoverensstemmende Resultater. Ved at anvende forskjellige Ammoniakmængder fandt jeg i et og samme Vand følgende Tal for Magnesia.

Med 9 Dele Vædske	og	1 Del konc. Amm.	0.2044	pCt.	MgO.
„ 5 „	—	„ 1 „	—	0.2061	„	„
„ 2 „	—	„ 1 „	—	0.2140	„	„

I et andet Vand fandtes paa samme Maade:

Med 9 Dele Vædske	og	1 Del konc. Amm.	0.2054	pCt.	MgO.
„ 2 „	—	„ 1 „	—	0.2112	„	„

Nødvendigheden af at tilsætte et saadant Overskud af Ammoniak for at faa en nøiagtig Bestemmelse af Magnesia efter denne Methode er altfor lidet fremhævet i de analytiske Lærebøger. Rimeligvis er denne mindre paaagtede Feilkilde Grunden til, at flere Kemikere har fundet meget uoverensstemmende og lave Tal for Magnesia i Søvandet. Forchhammer, hvis Resultater med Hensyn til Kalk- og Magnesiamængden stemmer godt overens med mine Analyser, inddamper Filtratet fra den fosforsure Ammoniakmagnesia til Tørhed og faar ved Opløsning af Residuet i Ammoniak altid en liden Rest af det fosforsure Salt. En saadan Inddampning er imidlertid ikke nødvendig, naar man blot før Fældningen koncentrerer Vædsken til det mindst mulige Volum og tilsætter det nødvendige Overskud af Ammoniak. Naar Bundfaldet derpaa efter 24 Timers Henstand frafiltreres, giver Filtratet ved Inddampning ingen Rest af fosforsur Ammoniakmagnesia.

Men uagtet disse Forholdsregler kan Magnesia ikke bestemmes med samme Sikkerhed i Havvandet, som Kalk og Svovlsyre. Nedenstaaende Tal viser Differentserne mellem Kontrolbestemmelserne:

I No.	33	fandtes	0.2160	og	0.2200	pCt.	MgO.
I „	35	—	0.2180	„	0.2207	„	„
I „	36	—	0.2173	„	0.2180	„	„

Største Differents = 0.004 pCt.

In Sample	1	the proportion was	0.0595	and	0.0602	p.ct. CaO.
In —	11	„ „ „	0.0580	„	0.0590	„ „
In —	26	„ „ „	0.0590	„	0.0596	„ „
In —	33	„ „ „	0.0585	„	0.0595	„ „
In —	34	„ „ „	0.0590	„	0.0593	„ „
In —	35	„ „ „	0.0585	„	0.0588	„ „
In —	36	„ „ „	0.0577	„	0.0579	„ „
In —	49	„ „ „	0.0578	„	0.0582	„ „
In —	50	„ „ „	0.0583	„	0.0588	„ „

Hence the greatest difference between any two determinations with the same sample of water is 0.001 per cent.

For determining the magnesia, the two solutions from which the lime-precipitates had been filtered off were evaporated in a platinum dish to about 150^{cc}, and then treated, for precipitation, with phosphate of soda, and with a concentrated solution of ammonia measuring one-third of the volume of the fluid. Unless ammonia be added in such excess, there is a risk of obtaining incongruous results. On treating different quantities of the fluid with the same proportion of ammonia, I found the following figures for magnesia.

With 9 parts of fluid and 1 part of conc. amm.		0.2044	p.ct.	MgO.
„ 5 „ „ „ „ 1 „ „	—	0.2061	„	„
„ 2 „ „ „ „ 1 „ „	—	0.2140	„	„

In another sample of water, the percentage thus found was —

With 9 parts of fluid and 1 part of conc. amm.		0.2054	p.ct.	MgO.
„ 2 „ „ „ „ 1 „ „	—	0.2112	„	„

The necessity, with this method, of adding ammonia in so great excess, to ensure a satisfactory determination of magnesia, has not been sufficiently emphasized in analytical class-books; and to this comparatively disregarded source of error, may no doubt be attributed the fact of divers chemists having obtained for magnesia, in their analyses of sea-water, results alike incongruous and low. Forchhammer, whose lime and magnesia determinations exhibit close agreement with my own, evaporates to dryness the solution from which the double phosphate of ammonia and magnesia has been filtered, and can, on dissolving the residue in ammonia, invariably detect traces of the phosphate. Meanwhile, evaporation does not constitute a necessary phase of the process, provided the fluid, previous to precipitation, be concentrated to the least possible volume, and then treated with ammonia in due excess; for, on the precipitate, after 24 hours, being filtered off, the solution, if evaporated to dryness, will not leave a trace of double phosphate of ammonia and magnesia.

But, even assuming every precaution, the magnesia in sea-water does not admit of being determined with the same degree of accuracy as do lime and sulphuric acid. The annexed figures show the extent to which the test-determinations were found to differ.

In Sample	33	the proportion was	0.2160	and	0.2200	p.ct. MgO.
In —	35	„ „ „	0.2180	„	0.2207	„ „
In —	36	„ „ „	0.2173	„	0.2180	„ „

Greatest difference: 0.004 per cent.

Svovlsyre.

Til denne Bestemmelse har jeg afveiet omtrent 100 Gr. Søvand, som tilføiedes 8—10 Draaber koncentreret Saltsyre og i Koghede bundfældtes med en Klorbariumopløsning, der tilsattes af en Bürette for at forhindre et skadeligt Overskud. Flasken med Bundfaldet hensattes derpaa i Kulden, og Filtreringen foretoges først efter 12 Timers Forløb.

Paa denne Maade erholdtes ved Kontrolbestemmelserne følgende Tal:

I No.	6	fandtes	0.2226	og	0.2236	pCt. SO_3.
I „	11	—	0.2145	„	0.2155	„ „
I „	12	—	0.2219	„	0.2221	„ „
I „	40	—	0.2176	„	0.2195	„ „
I „	42	—	0.2156	„	0.2165	„ „

Største Differents = 0.0019 pCt.

Hvis man lader Bundfaldet afsætte sig i Varmen og derpaa frafiltrerer det ved den samme Temperatur, taber man altid en Del af den svovlsure Baryt, da dette Salt er noget opløseligt i varmt Søvand, og Filtratet udskiller derfor ved Afkjøling og Henstand et krystallinsk Bundfald af Tungspath. Denne Opløselighed skyldes det tilstedeværende Klornatrium. Jeg har overbevist mig om dette ved sammenlignende Forsøg med en Kogsaltopløsning af en Koncentration, der omtrentlig svarede til Søvandets. Tilsættes en Smule Svovlsyre eller svovlsur Kali til et vist Kvantum af denne Opløsning, vil der trænges mere af en fortyndet Klorbariumopløsning for deri at frembringe Bundfald, end der er nødvendig til samme Volumen rent Vand, hvortil er tilsat den lige Mængde Svovlsyre. De Feil, der kan opstaa i Bestemmelserne, hvis man frafiltrerer Bundfaldet ved almindelig Vandbadtemperatur (80°—90°) er vistnok ikke betydelige, men giver sig dog klart tilkjende, da de ialmindelighed er flere Gange større end Differentserne mellem de ovennævnte Kontrolbestemmelser[1].

[1] Som Exempler kan anføres følgende Analyser:

				I Varmen:	*I Kulden:*
I No. 20	fandtes	ved	Filtrering	0.2172	0.2204
I „ 37	—	„	—	0.2140	0.2194
I „ 38	—	„	—	0.2144	0.2183
I „ 44	—	„	—	0.2087	0.2120
I „ 46	—	„	—	0.2140	0.2205
I „ 48	—	„	—	0.2110	0.2150
I „ 49	—	„	—	0.2207	0.2215

Ved ikke at tage Hensyn til den svovlsure Baryts Opløselighed i varmt Søvand vil man altsaa faa en Feil, der ialmindelighed beløber sig til omtrent 0.004 pCt. R. Fresenius har (Zeitschrift für anal. Chemie 9, S. 52) undersøgt forskjellige Saltes opløsende eller forurensende Evne ligeoverfor den svovlsure Baryt og fundet, at Klornatrium ikke har nogen skadelig Indflydelse paa Svovlsyrebestemmelsen. Ved Analyser, der kræver en speciel Nøiagtighed, har altsaa dette blot sin Rigtighed under Forudsætning af, at Bundfaldet faar Anledning til at afsætte sig i Kulden. Hvorvidt Fresenius ved sine Forsøg har iagttaget denne Forsigtighedsregel, fremgaar ikke af hans Afhandling, men Differentsen mellem to Bestemmelser, han har udført med eller uden Indvirkning af Klornatrium, falder ialtfald til

Sulphuric Acid.

For determining this constituent, I weighed 100 gr. of sea-water, and treated the fluid with 8—10 drops of concentrated hydrochloric acid, precipitation — at the boiling-point — being then effected with a solution of chloride of barium, which was gradually added from a burette, with a view to prevent injurious excess. The phial containing the solution was now removed to a cold room, where, after the lapse of 12 hours, the precipitate was filtered off.

The following are the results of the test-determinations: —

In Sample	6	the proportion was	0.2226	and	0.2236	p.ct. SO_3
In —	11	„ „ „	0.2145	„	0.2155	„ „
In —	12	„ „ „	0.2219	„	0.2221	„ „
In —	40	„ „ „	0.2176	„	0.2195	„ „
In —	42	„ „ „	0.2156	„	0.2165	„ „

Greatest difference: 0.0019 per cent.

By allowing the precipitate to form at about the boiling-point, and then filtering it off at the same temperature, some of the sulphate of baryta — a salt partially soluble in warm sea-water — will be invariably lost; and hence a crystalline deposit of sulphate of baryta is observed in the filtered solution some time after its cooling. The solubility of the salt is due to the presence of chloride of sodium: of this I am convinced from comparative experiments with a solution of common salt, corresponding in concentration as near as may be to sea-water. Now, if to a given quantity of this solution be added a little sulphuric acid or sulphate of potash, it will require more of a diluted solution of chloride of barium to effect precipitation than is necessary for the same volume of pure water treated with the same proportion of sulphuric acid. True, the errors in determination that can result from filtering off the precipitate at the ordinary water-bath temperature (80°—90°), are not great, — but they are quite appreciable, being many times greater indeed than the differences between the test-determinations alluded to above.[1]

[1] This will appear from the following results: —

				Filtered warm.	*Filtered cold.*	
In Sample	20	the proportion	was	0.2172	0.2204	p.ct. SO_3.
In —	37	„ „	„	0.2140	0.2194	„ „
In —	38	„ „	„	0.2144	0.2183	„ „
In —	44	„ „	„	0.2087	0.2120	„ „
In —	46	„ „	„	0.2140	0.2205	„ „
In —	48	„ „	„	0.2110	0.2150	„ „
In —	49	„ „	„	0.2207	0.2215	„ „

Hence, the error that arises from disregarding the solubility of sulphate of baryta in warm sea-water, will generally amount to 0.004 per cent. R. Fresenius has examined (Zeitschrift für anal. Chemie 9, S. 52) divers salts, with a view to ascertain their dissolving or contaminating properties in relation to sulphate of baryta, and has found chloride of sodium to have no disturbing influence on sulphuric acid determinations. This, then, in analyses craving exceptional accuracy will be found to hold good only in the event of the precipitate being allowed to form at a low temperature. Whether Fresenius had regard to this precaution, does not appear from his treatise; but the difference between two determinations he has performed, one with and one without the presence of chloride of sodium, is certainly in favour of sulphate

Kali.

Denne Bestemmelse, der kræver lang Tid og omstændeligt Arbeide, har jeg som for nævnt kun udført i nogle faa Vandprøver. Hertil har jeg anvendt omtrent 50 Gram Søvand og fraskilt Kalk og Magnesia efter den af Classen angivne Methode[1] med oxalsur Ammoniak, Alkohol og Eddikesyre. Filtratet blev inddampet til Tørhed, Ammoniaksalterne bortjagede og den tilbageblevne Saltmasse befriet fra Svovlsyre ved gjentagne Glødninger med et Overskud af Salmiak. De samlede Klorider blev derpaa opløste i Vand, overførte i Platindobbeltsalte og derpaa behandlede efter den Methode, der af Fresenius foreskrives til Bestemmelsen af Kali og Natron i Mineralvand. Det er imidlertid meget vanskeligt at faa al Svovlsyre fjernet ved Afdampning med Salmiak, og det fremstillede Kaliumplatinklorid indeholdt derfor altid Spor af svovlsure Salte. Der er saaledes en Mulighed for, at de fundne Kalimængder er noget for høie, skjønt Bestemmelserne i de forskjellige Vandprøver stemmer nogenlunde godt overens med hinanden.

Hvis man iforveien veier de samlede Klorider og derfra trækker den erholdte Klorkaliummængde, skulde man altsaa kunne finde Søvandets Klornatriumgehalt. Men da Kloriderne ialmindelighed ere forurensede med smaa Mængder Svovlsyre og Magnesia, der ikke er blevet fuldstændig fjernede ved de foregaaende Operationer, og Kulrester fra Ammoniaksaltenes Afdampning, vil man ved denne indirekte Bestemmelse faa altfor høie og uoverensstemmende Tal for Klornatrium. Man vil paa denne Maade ialmindelighed finde omkring 2.8 pCt. af dette Salt, medens man efter en anden Beregning, som senere skal omtales, neppe faar et Tal der overskrider 2.7 pCt.

Potash.

To determine this compound is a long and laborious task, and, as previonsly stated, I have performed it in only a few of the samples of sea-water. For this purpose, I precipitated, by Classen's method,[1] with oxalate of ammonia, alcohol, and acetic acid, the lime and magnesia in 50^{gr} of sea-water. The filtered solution was evaporated to dryness, the ammonia compounds volatilized, and the sulphuric acid in the residue got rid of by repeatedly heating to redness, with sal-ammoniac in excess. The several chlorides were then dissolved in water, transformed into double chloride of platinum, and then treated according to the method devised by Fresenius for determining potash and soda in mineral waters. Meanwhile, it is exceedingly difficult to get rid of all the sulphuric acid by evaporation with sal-ammoniac; and hence the double chloride of potassium and platinum invariably exhibited traces of sulphates. The amounts found for potash may therefore be a little too high, though the determinations performed with different samples of water agree pretty closely *inter se.*

Now, by weighing beforehand the several chlorides, and then subtracting the total amount of chloride of potassium, the proportion of chloride of sodium present in sea-water might accordingly be found. But, unfortunately, the chlorides are as a rule contaminated with small quantities of sulphuric acid and magnesia, that were not got rid of in the foregoing operations, along with a residue of carbonized organic matter resulting from the volatilization of the sal-ammoniac; and hence the figures thus indirectly computed for chloride of sodium will be alike incongruous and too high. This method will generally give about 2.8 per cent of the salt, whereas the amount by another mode of computation — to be afterwards noticed — does not exceed 2.7 per cent.

Klor.

Med Hensyn til disse Bestemmelser, der er udførte ombord ved Titrering, henviser jeg til Hr. Tornøe's Afhandling om Saltmængden i Havet. For at bestemme Vandets samlede Saltgehalt har Hr. Tornøe inddampet en vis Portion deraf til Tørhed, glødet Residuet i nogle Minuter over en Bunsen's Lampe og derpaa ved Titrering korrigeret for den tabte Saltsyre. Efterat have udført disse Bestemmelser i nogle Vandprøver, har han paa Grundlag

Chlorine.

As regards these determinations, which were performed on board by titration, the reader is referred to Mr. Tornøe's Memoir on the amount of salt in seawater. To determine the total amount of salt in oceanwater, Tornøe evaporated a given quantity to dryness, kept the residue for a few minutes at a red-heat over one of Bunsen's lamps, and then determined by titration the loss of hydrochloric acid. After performing these deter-

Fordel for den svovlsure Baryts Opløselighed, om den end er for ubetydelig til at kunne tages med i Betragtning, naar den kun refererer sig til to Forsøg.

Den svovlsure Baryts Opløselighed i koldt Søvand er neppe paaviselig. Ved Tilsætning af en fortyndet Klorbariumopløsning fremkommer her Bundfaldet ligesaa hurtig som i en Opløsning af svovlsur Kali i rent Vand.

Klormagnesium forekommer i Søvandet i altfor ringe Mængde til at kunne have nogen skadelig Indflydelse paa Svovlsyrebestemmelsen. Jeg har desuden ved Forsøg overbevist mig om, at selv en mere koncentreret Opløsning af dette Salt ikke har nogen mærkelig Indvirkning paa Udfældningen af den svovlsure Baryt.

[1] Zeitschrift für anal. Chemie 1879, B. 4, S. 374.

of baryta's solubility, though too inconsiderable to be taken into account, referring as it does to only two determinations.

That sulphate of baryta is also soluble in cold sea-water, will hardly admit of proof. On adding a diluted solution of chloride of barium, the precipitate forms as rapidly as in a solution of sulphate of potash prepared with pure water.

Chloride of magnesium occurs far too sparingly in sea-water to admit of its disturbing the accuracy of sulphuric acid determinations. Besides, experiments have convinced me, that a comparatively concentrated solution of that salt does not appreciably affect the precipitation of sulphate of baryta.

[1] Zeitschrift für anal. Chemie 1879, B. 4, pag. 374.

deraf beregnet Saltgehalten i de øvrige ved Hjælp af Klormængden og den specifiske Vægt.

I den følgende Tabel har jeg ordnet Bestemmelserne efter Nummeret af de Stationer, hvor Vandprøverne er optagne. Bestanddelene er i Tabel I beregnede som Procenter af Søvandet. I Tabel II har jeg i Lighed med Forchhammer udregnet Bestanddelenes Forhold til Klormængden, naar denne sættes = 100.

Egenvægten af Søvandet er i Tabellen udtrykt ved 17°.5 C., sammenlignet med Vand af samme Temperatur.

De Tal, der er satte i Parenthes, er enten fundne ved Beregning eller udledede af Bestemmelser fra nærliggende Vandprøver.

minations with divers samples of sea-water, he computed from the results obtained the proportion of salt in the others; by means of the amount of chlorine and the specific gravity.

In the accompanying Table the numbers of the determinations are arranged to correspond with those of the Stations at which the samples of sea-water were collected. In Table I, the amounts are computed as percentages of the sea-water examined. In Table II, I have, in common with Forchhammer, computed the amounts as percentages of the proportion of chlorine, taking the latter at 100.

The specific gravities of the samples are reduced in the Table to 17°.5 C., as compared with pure water of the same temperature.

The figures parenthetically enclosed were either found by computation or deduced from determinations with samples drawn in some adjacent locality.

Table I.

No.	Stat. No.	Nordlig Bredde. (North Latitude.)	Længde fra Greenwich. (Longitude from Greenwich.)	Dybde i engl. Favne. (Depth in English Fathoms.)	Egenvægt ved 17.5°. (Specific Gravity at 17.5°.)	CaO.	MgO.	K_2O.	SO_3.	Cl.	Samlet Saltmængde. (Amount of Salt measured.)	Anmærkninger. (Remarks.)
1	3	61° 52′	5° 15.3′ E.	618	1.0266	0.0595 / 0.0602	0.2214		0.2202		3.51	Sognefjorden.
2	37	62 28.3	2 29 W.	690	1.0270	0.0573	0.2260		0.2242		3.56	
3	51	65 53	7 18	1163	1.02665	0.0575	0.2197		0.2192		3.52	
4	52	65 47.5	3 7	0	1.0268	0.0585	0.2249		0.2273		3.53	
5	52	65 47.5	3 7	515*	1.02675	0.0566	0.2190		0.2243		3.53	
6	52	65 47.5	3 7	1861	1.0267	0.0572	0.2202	0.0476 / 0.0470	0.2236 / 0.2226		3.52	
7		Nordpynt af Naalsø. Northern Extremity of Naalsø.		0	1.0269	0.0580					3.55	
8		63° 23′	20° 45′	0	1.0266	0.0575	0.2177		0.2190		(3.50)	Islands Sydkyst. South Coast of Iceland.
9	87	64 2	5 35 E.	498	(1.0266)	0.0594	0.2210		0.2220			
10	107	65 21	10 44	172		0.0574	0.2180		0.2197		(3.51)	
11	143	66 58	10 33	0	1.0257	0.0580 / 0.0590	0.2134 / 0.2134		0.2145 / 0.2155	1.899	3.42	
12	143	66 58	10 33	189	1.0265	0.0572	0.2230		0.2219 / 0.2221	1.956	3.52	
13	183	69 59.5	6 15	0	1.0267	0.0594	0.2240		0.2221	1.952	3.52	
14	183	69 59.5	6 15	1600*	(1.0267)	0.0560	0.2260					
15	184	70 4	9 50	1547	1.0265	0.0572	0.2219		0.2204 / 0.2206	1.935	3.50	
16	189	69 41	15 42	0	1.0263	0.0577				1.923	3.48	
17	189	69 41	15 42	860	1.0266	0.0587				1.931	3.50	
18	215	70 53	2 0 W.	0	1.0267	0.0561	0.2290		(0.2183)	1.945	3.52	
19	215	70 53	2 0	200*	1.0267	0.0586	0.2175		0.2230	1.945	3.52	
20	226	71 0	7 55	0	1.0261	0.0575	0.2159		0.2204	1.893	3.43	Nær Jan Mayen. Off Jan Mayen.
21	226	71 0	70 55	340	1.02635	0.0598	0.2202	0.0479	0.2226	1.936	3.49	
22	240	69 2	11 26	0	(1.0264)	0.0570	0.2240		0.2205		(3.48)	
23	245	68 21	2 5	0	1.0268	0.0589	0.2206		0.2197		3.53	
24	247	68 55	2 24 E.	0	1.0267	0.0582	0.2250		0.2215	1.954	3.53	
25	247	68 55	2 24	500*	1.0266	0.0586	0.2160		0.2226	1.927	3.53	
26	254	67 27	13 25	140	1.0267	0.0590 / 0.0596	0.2240		0.2221	1.931	3.51	Vestfjorden.
27	256	70 8.5	23 4	0		0.0312	0.1219		0.1246	1.118	2.02	
28	264	70 56	35 37	0	1.0264	0.0584	0.2184	0.0451	0.2187	1.929	3.49	
29	264	70 56	35 37	86	1.0266	0.0587	0.2218	0.0492	0.2187	1.934	3.51	
30	275	74 8	31 12	0	1.0265	0.0565	0.2170		0.2230	1.935	3.50	
31	293	71 7	21 11	0		0.0584				(1.909)	(3.45)	
32	293	71 7	21 11	95		0.0570				1.943	3.51	
33	295	71 59	11 40	0	1.02665	0.0595 / 0.0585	0.2160 / 0.2200		0.2235	1.942	3.52	
34	295	71 59	11 40	100*	1.0266	0.0593 / 0.0590	0.2232		0.2212	1.942	3.51	
35	295	71 59	11 40	600*	1.0265	0.0588 / 0.0585	0.2180 / 0.2207		0.2220	1.936	3.50	
36	295	71 59	11 40	1110	1.0266	0.0577 / 0.0579	0.2173 / 0.2180	0.0482	0.2200	1.934	3.51	
37	297	72 36.5	5 12	0	1.0262	0.0580	0.2203		0.2194	1.928	3.48	
38	297	72 36.5	5 12	1280	1.0263	0.0593	0.2215		0.2183	1.926	3.48	
39	300	73 10	3 22 W.	0	1.0247	0.0552	0.2037		0.2051	1.810	3.278	I Drivisen. Drift Ice.
40	303	75 12	3 2 E.	0	1.02615	0.0576	0.2153		0.2176 / 0.2195	1.914	3.46	
41	304	75 3	4 51	1735	2.0263	0.0577	0.2240		0.2218	1.940	3.49	
42	306	75 0	10 27	1334	1.0263	0.0587	0.2178		0.2156 / 0.2165	1.920	3.47	
43	323	72 54	21 51	223	1.0265	0.0586	0.2199		0.2250	1.933	3.50	
44	339	76 30	15 29	0	1.0254	0.0554	0.2102		0.2120	1.867	3.37	Spitsbergens Sydspids. Southern Extremity of Spitzb.
45	350	76 26	0 29 W.	0	1.0254	0.0555	(0.2155)		0.2144	1.872	3.37	Nær Isgrændsen. In close proximity to the Ice.
46	350	76 26	0 29	500*	1.0263	0.0563	0.2103		0.2205	1.922	3.48	
47	350	76 26	0 29	1686	1.0260	0.0573	0.2224		0.2193	1.916	3.45	
48	351	77 50	0 9	0		0.0570	0.2120		0.2150		(3.40)	
49	362	79 59	5 40 E.	0	1.02615	0.0578 / 0.0582	0.2156		0.2215	1.917	3.503 / 3.46	
50	362	79 59	5 40	459	1.0262	0.0588 / 0.0583	0.2165	0.0454	0.2194	1.922	3.47	
51	373	68 10	14 26	120	1.0260	0.0575	0.2230		0.2213			Isfjorden.

* Dette Mærke betegner de intermediære Dybder. — The Asterisk denotes Intermediate Depths.

Tabel II.

(Cl. = 100).

No.	CaO.	MgO.	SO_3.	No.	CaO.	MgO.	SO_3.
11	3.081	11.237	11.322	33	3.038	11.225	11.509
12	2.924	11.401	11.355	34	3.046	11.493	11.390
13	3.043	11.475	11.378	35	3.029	11.330	11.467
15	2.956	11.416	11.136	36	2.988	11.254	11.479
16	3.000			37	3.008	11.426	11 379
17	3.040			38	3.079	11.500	11.334
18	2.884	11.773		39	3.048	11.254	11.365
19	3.013	11.182	11.465	40	3.009	11.249	11.418
20	3.037	11.405	11.643	41	2.974	11.546	11.434
21	3.088	11.374	11.498	42	3.057	11.344	11.253
24	2.978	11.515	11.336	43	3.032	11.376	11.640
25	3.041	11.209	11.551	44	2.967	11.259	11.157
26	3.071	11.600	11.502	45	2.964		11.453
27	2.790	10.903	11.145	46	2.923	11.410	11.472
28	3.027	11.326	11.337	47	2.991	11.608	11.446
29	3.035	11.468	11.308	49	3.026	11.257	11.555
30	2.920	11.214	11.473	50	3.044	11.264	11.254
32	2.933						

Som der vil sees af Tabel I, er Kalkgehalten i de Søvandsprøver, som er medbragte fra det store Hav og har en Egenvægt af 1.0260—1.0270, aldrig fundet høiere end 0.0598 pCt. eller lavere end 0.0560 pCt. Forøvrigt er der i 42 Stationer kun 11 Kalkbestemmelser, som ikke ligger mellem Tallene 0.0590 og 0.0570, men dels falder over, dels under disse Grændser, og ved hvilke Differentserne altsaa overskrider 0.002 pCt. Skjønt altsaa den største Del af de fundne Tal afviger saalidet fra hinanden, at Differentserne mellem dem ikke er synderlig større end Feilene ved de enkelte Analyser og forsaavidt kan sættes ude af Betragtning, viser dog de forud anførte Kontrolbestemmelser, at en Forskjel af 0.003—0.004 pCt. ikke tilfredsstillende kan forklares paa denne Maade. Men disse Uoverensstemmelser er for det første saa ubetydelige og for det andet fundne paa saa forskjellige Steder og under saa uligeartede Vilkaar, at det ikke er muligt at uddrage nogen Regel, som kan forklare eller sandsynliggjøre dem. De Vandprøver, der er tagne med i Betragtning ved Afgjørelsen af disse Spørgsmaal, er allesammen hentede fra det aabne ufortyndede Hav, og Variationerne i Egenvægten (1.0260—1.0270) er derfor altfor smaa til at kunne have nogen mærkelig Indflydelse paa Kalkbestemmelsen. At dømme efter de fortyndede Vandprøver (39, 44 og 45) falder Kalkmængden først under 0.0560 pCt., naar Egenvægten nærmer sig 1.0250.

Magnesia kan vistnok ikke bestemmes med samme Nøiagtighed som Kalken, men da den forekommer i omtrent den firedobbelte Mængde vil Forskjellighederne i Søvandets Egenvægt her blive mere mærkbare. Sammenligner man Søvandets midlere Magnesiagehalt med de Tal, der angiver Mængden af den samme Bestanddel i de mere fortyndede Vandprøver (No. 11, 39 og 44) vil man finde, at en Formindskelse i den specifiske Vægt af 1 i tredie Decimal svarer til en Forskjel i Magnesiamængden af 0.008—0.010 pCt. Skjønt denne Beregning naturligvis ikke kan

Tabel II.

(Cl. = 100).

No.	CaO.	MgO.	SO_3.	No.	CaO.	MgO.	SO_3.
11	3.081	11.237	11.322	33	3.038	11.225	11.509
12	2.924	11.401	11.355	34	3.046	11.493	11.390
13	3.043	11.475	11.378	35	3.029	11.330	11.467
15	2.956	11.416	11.136	36	2.988	11.254	11.479
16	3 000			37	3.008	11.426	11.379
17	3.040			38	3.079	11.500	11.334
18	2.884	11.773		39	3.048	11.254	11.365
19	3.013	11.182	11.465	40	3.009	11.249	11.418
20	3.037	11.405	11.643	41	2.974	11.546	11.434
21	3.088	11.374	11.498	42	3.057	11.344	11.253
24	2.978	11.515	11.336	43	3.032	11.376	11.640
25	3.041	11.209	11.551	44	2.967	11.259	11.157
26	3.071	11.600	11.502	45	2.964		11.453
27	2.790	10.903	11.145	46	2.923	11.410	11.472
28	3.027	11.326	11.337	47	2.991	11.608	11.446
29	3.035	11.468	11.308	49	3.026	11.257	11.555
30	2.920	11.214	11.473	50	3.044	11.264	11.524
32	2.933						

As will be seen from Table I, the amount of lime in the various samples of water collected in the open sea, with a specific gravity ranging from 1.0260 to 1.0270, was never greater than 0.0598 per cent or less than 0.0560 per cent. For the rest, of the lime-determinations performed with samples from 42 Stations, there are only 11 that do not lie between the figures 0.0590 and 0.0570, but which either exceed or do not reach those limits, exhibiting accordingly differences of more than 0.002 per cent. By far the greater part of the results differ indeed so inconsiderably *inter se*, that the differences are found to be very little greater than the errors in the several analyses, and may therefore be safely disregarded; but a difference of 0.003 or 0.004 per cent, as appears from the test-determinations alluded to above, will not admit of being thus explained. Meanwhile, the want of agreement is in itself so slight, and refers to samples of water collected in such widely different localities, and under conditions so essentially dissimilar, that no rule can be deduced by which to explain or render probable such errors as these. The samples in question were all of them collected from the undiluted water of the open sea: and hence the variation in specific gravity is much too slight to have had any appreciable effect on the amount of lime. Judging from the diluted samples, the amount of lime does not fall below 0.0560 per cent till the specific gravity approaches 1.0250.

The magnesia cannot indeed be determined with the same degree of accuracy as the lime; but, occurring as it does in a proportion four times as great, the effect of the differences in specific gravity will naturally be more appreciable. On comparing the mean amount of magnesia in ordinary seawater with the figures indicating the proportion of that constituent in the more diluted samples (Nos. 11, 39, and 44), a reduction in the specific gravity of 0.001 will be found to represent a difference of from 0.008 to 0.010 per cent in the amount of magnesia. This computation, though

gjøre Fordring paa nogen Nøiagtighed, viser den ialfald, at Forskjellighederne i Vandets specifiske Vægt i Forening med Feilene ved de enkelte Analyser er tilstrækkelige til at forklare de fleste Afvigelser i de fundne Magnesiamængder. De Uoverensstemmelser, der ikke kan udtydes paa denne Maade, er (ligesom ved Kalken) saa smaa og uregelmæssige, at der ikke kan tillægges dem nogen afgjørende Beviskraft.

Forat bedømme de Tal, der er fundne for Svovlsyren, maa man tage de samme Hensyn til Vandets specifiske Vægt som ved Magnesia. Men der maa tillige bemærkes, at Svovlsyrebestemmelserne er i Besiddelse af en langt større Paalidelighed, da Feilene ved de enkelte Analyser, saaledes som Kontrolforsøgene viser neppe overstiger 0.002 pCt. De største Afvigelser i de fundne Svovlsyremængder er 0.2160 og 0.2273 pCt. i to Vandprøver, hvis specifiske Vægt var 1.0263 og 1.0268. Omend disse Differentser for en Del kan skyldes de tilsvarende Forskjelligheder i Egenvægten, er de dog for betydelige til, at denne Forklaring kan være tilstrækkelig. Desuden findes der ogsaa nogle Vandprøver af samme specifiske Vægt, der i Svovlsyregehalten differerer 0.005—0.006 pCt., hvilket er formeget til at kunne betragtes som Feil i Analysen. Skjønt disse Uoverenssemmelser, der kun forekommer paa nogle faa Punkter, er endnu ubetydeligere end ved Magnesia, bliver de dog vanskeligere at forklare paa Grund af Bestemmelsernes større Paalidelighed.

Forat betragte dette og de foregaaende Spørgsmaal fra forskjellige Sider har jeg i den følgende Tabel opstillet Middeltallene for Kalk, Magnesia, Svovlsyre og Klor i Overfladen, Bunden og de mellemliggende Dyb. Jeg har tillige udregnet disse Bestanddeles Forhold til hinanden ved at sætte Klor eller Svovlsyre = 100.

	Overfladen.	Bunden.	Mellemliggende Dyb.	Gjennemsnitsgehalt for hele Havet.
Middeltal for Cl. . . .	1.930	1.933	1.934	1.932
— - Egenvægt	1.0265	1.0265	1.0266	1.0265
— - CaO . .	0.0576	0.0581	0.0577	0.0578
— - MgO . .	0.2205	0.2207	0.2200	0.2203
— - SO_3 . . .	0.2211	0.2208	0.2223	0.2214
CaO : Cl (Cl = 100) . .	2.98	3.01	2.98	2.99
MgO : Cl	11.42	11.42	11.37	11.40
SO_3 : Cl.	11.46	11.42	11.49	11.46
CaO : SO_3 (SO_3 = 100)	26.05	26.32	25.95	26.11
MgO : SO_3	99.73	99.95	98.96	99.55

Som der vil sees af den sidste Tabel, afviger Middeltallene for Kalk og Magnesia saa yderst ubetydelig fra hinanden, at disse Variationer ganske kan sættes ud af Betragtning.

with no pretensions to accuracy, will at all events show, that differences in specific gravity and errors of analysis generally suffice to account for the want of agreement in the computed amounts of magnesia: and when, as is the case with the lime, this cannot be so explained, the variation is alike too slight and too irregular to admit of its possessing any real demonstrative power.

When estimating the accuracy of the figures found for the sulphuric acid, no less regard must be had to the specific gravity of the water than with magnesia. It must also, however, be borne in mind, that the sulphuric acid determinations are distinguished by a far higher degree of accuracy, the errors of analysis scarcely exceeding 0.002 per cent. The most considerable differences in the results for sulphuric acid — computed from two samples of water, specific gravity respectively 1.0263 and 1.0268 — amount to 0.2160 and 0.2273 per cent. True, this diversity can be partly ascribed to a corresponding deviation in specific gravity; but they are much too considerable to be thus accounted for. Besides, some of the samples with the same specific gravity differ in their proportion of sulphuric acid to the extent of 0.005, or 0.006 per cent. — too considerably, therefore, for the discrepancy to be regarded as a mere error of analysis. This want of agreement, though referring to water from a few localities only, and less considerable even than that in magnesia, is nevertheless difficult to explain, by reason of the greater accuracy of the determinations.

With a view to the better apprehension of this and the foregoing questions, I have tabulated the mean amounts of lime, magnesia, sulphuric acid, and chlorine in water from the surface, from intermediate depths, and from the bottom. I have likewise estimated the relative proportion of these compounds, with 100 equivalents of chlorine or sulphuric acid as the standard of computation.

	Surface.	Bottom.	Inter. Depths.	Mean Value.
Mean Value Chlorine	1.930	1.933	1.934	1.932
.. .. Sp.Gravity	1.0265	1.0265	1.0266	1.0265
.. .. CaO . .	0.0576	0.0581	0.0577	0.0578
.. .. MgO . .	0.2205	0.2207	0.2200	0.2203
.. „ SO_3 . . .	0.2211	0.2208	0.2223	0.2214
CaO : Cl (Cl = 100) . .	2.98	3.01	2.98	2.99
MgO : Cl	11.42	11.42	11.37	11.40
SO_3 : Cl.	11.46	11.42	11.49	11.46
CaO : SO_3 (SO_3 = 100)	26.05	26.32	25.95	26.11
MgO : SO_3	99.73	99.95	98.96	99.55

As appears from the Table, the mean values for lime and magnesia vary so inconsiderably *inter se* that we may safely disregard these differences.

En nærmere Berørelse med Havbunden og dens dyriske Liv har altsaa ingen mærkbar Indflydelse paa Havets Sammensætning med Hensyn til disse Bestanddele. Middeltallene for Svovlsyre viser større Afvigelser end de tilsvarende for Magnesia, skjønt man skulde have ventet, at det Modsatte havde fundet Sted. Forskjellighederne er dog i dette Tilfælde ligesom i de foregaaende for ubetydelige til at kunne afgive noget bestemt Bevis for, at der virkelig existerer nogen tilsvarende Eiendommelighed i Havet. At Svovlsyregehalten i de mellemliggende Dyb skulde være høiere end ved Bunden og Overfladen, er en Antagelse, der *a priori* ikke har nogen Sandsynlighed for sig.

Jeg kommer senere muligens tilbage til disse Spørgsmaal angaaende Havets Beskaffenhed i Dybet, da jeg for Øieblikket er ifærd med at undersøge de Prøver, som under Expeditionens Dybdemaalinger optoges af Havbunden. Efter de foreløbige Resultater i denne Retning anser jeg mig imidlertid berettiget til at antage, at dette Dybvandsslam er af en temmelig ensartet Beskaffenhed.

Forat betragte de her foreliggende Bestemmelser fra et andet Synspunkt, har jeg i efterfølgende Tabel ordnet Middel- og Forholdstallene for Søvandets Bestanddele efter de Breddegrader, mellem hvilke Vandprøverne er optagne.

	80°—71°	71°—66°	66°—62°
Middeltal for Cl	1.929	1.937	
— - Egenvægt	1.0264	1.0265	1.0268
— - CaO	0.0580	0.0579	0.0577
— - MgO	0.2190	0.2219	0.2205
— - SO_3	0.2208	0.2210	0.2223
CaO : Cl (Cl = 100)	3.01	2.99	
MgO : Cl	11.35	11.45	
SO_3 : Cl	11.45	11.41	
CaO : SO_3 (SO_3 = 100)	26.27	26.20	25.95
MgO : SO_3	99.18	100.4	99.19

Middeltallene for Kalkmængden viser i denne Tabel den samme Uforanderlighed som i den foregaaende. Forskjellighederne ved Magnesia er derimod større, men i Betragtning af Analysens mindre Sikkerhed berettiger de ikke til nogen Slutning med Hensyn til et tilsvarende Forhold i Havet. Svovlsyren har sit Maximum søndenfor den nordlige Polarkreds, hvor Middeltallet er 0.2223 pCt. Vandets høiere Egenvægt i denne Del af Havet staar maaske i Samklang med denne Forøgelse af Svovlsyremængden, skjønt man ved Sammenligning med Forchhammers Analyser af nærliggende Vandprøver, hvoraf ingen er hentede nordenfor den 62de Breddegrad, skulde tro, at Havet virkelig i disse sydligere Egne var i Besiddelse af en større Svovlsyregehalt. Forchhammer finder nemlig som Middeltal for Svovlsyren mellem den 60de og 62de Breddegrad 0.230 pCt. Men efter al Rimelighed skriver denne Uoverensstemmelse

Hence, close proximity to the bottom and the animal life prevailing there, is found to have no appreciable influence on the composition of ocean-water, — as regards, at least, this division of its constituents. The mean values for sulphuric acid exhibit greater variation than the figures computed for magnesia, though there was reason to expect the reverse. But here also, as in the case previously noticed, the differences are much too small to admit of their furnishing conclusive proof of some corresponding peculiarity actually distinguishing the water of the ocean. That the proportion of sulphuric acid should be greater at intermediate depths than at the bottom and the surface, is, reasoning *a priori*, an improbable assumption.

Possibly I shall have occasion, to resume the discussion of questions relating to the composition of the ocean at great depths, being at present engaged on the examination of the samples of the bottom brought up on the Expedition when deep-sea soundings were taken. Judging from the first results in that direction, this deep-sea ooze would appear to be comparatively uniform in composition.

With the object of presenting the determinations here described from another point of view, I have, in the following Table, arranged the mean and proportional values of the constituent parts of the sea-water according to the parallels of latitude within which the samples of bottom-water were collected.

	80°—71°	71°—66°	66°—62°
Mean Value Chlorine	1.929	1.937	
„ „ Specific Gravity	1.0264	1.0265	1.0268
„ „ CaO	0.0580	0.0579	0.0577
„ „ MgO	0.2190	0.2219	0.2205
„ „ SO_3	0.2208	0.2210	0.2223
CaO : Cl (Cl = 100)	3.01	2.99	
MgO : Cl	11.35	11.45	
SO_3 : Cl	11.45	11.41	
CaO : SO_3 (SO_3 = 100)	26.27	26.20	25.95
MgO : SO_3	99.18	100.4	99.19

The mean values here computed for lime exhibit the same uniformity as those in the preceding Table, whereas the differences in the proportion of magnesia are greater. But, if regard be had to the fact, that the analyses from which they were deduced are to a certain extent defective, their results, though comparatively incongruous, will not warrant inferring a similar peculiarity in the water of the ocean. The amount of sulphuric acid reaches its maximum south of the Arctic Circle, where the mean amount is 0.2223 per cent. The greater specific gravity of the water in this tract of the ocean may possibly be connected with this increase in the proportion of sulphuric acid, though a comparison with Forchhammer's analyses of samples collected in adjacent localities, none of which, however, lay north of the 62nd parallel of latitude, would seem to favour the assumption, that the ocean, in those southern regions, does really con-

sig fra en stadig Feil i hans Analyser, da han nemlig til Udfældning af Svovlsyren har benyttet sig af den salpetersure Baryt, hvorved man — som senere er bevist — faar et stærkt forurenset Bundfald.

Af den sidste og de foregaaende Tabeller fremgaar det, at fra hvilken Side man end ser alle disse Bestemmelser af Kalk, Magnesia og Svovlsyre, kan de ikke med Bestemthed bevise nogen Foranderlighed i Søvandets Sammensætning; men det bør tillige bemærkes, at de Afvigelser, der er vanskeligst at forklare, især deleshed fremkommer ved Svovlsyrebestemmelserne.

Den Antagelse, at Havet i hele sin Dybde er en ensartet Blanding, hvori den nøiagtigste kemiske Analyse neppe kan paavise nogen Forskjellighed, bekræftes ved de her foreliggende Undersøgelser i endnu høiere Grad end ved de tidligere. Jeg har nemlig ikke nogensinde fundet saa store Uoverensstemmelser som de, der paa enkelte Steder er fremkomne ved Forchhammers og andre Kemikeres Analyser.

Retter man nu Opmærksomheden paa de fortyndede Vandprøver, hvis Egenvægt er under 1.0260, vil man heller ikke her finde nogen Forandring i det konstante Forhold mellem Bestanddelene. Station 300, 339 og 350, hvor Egenvægt og Klorgehalt er formindskede ved nærliggende Ismassers Smeltning, viser en nøiagtig tilsvarende Forskjellighed for de øvrige Bestanddeles Vedkommende. I Station 143, der er beliggende i Nærheden af den norske Kyst, og hvis Overfladevand som følge heraf er noget fortyndet, har jeg ved to Bestemmelser fundet en temmelig høi Kalkgehalt, medens derimod Magnesia og Svovlsyre fuldkommen retter sig efter Klormængden. Dette fortjener maaske en Smule Opmærksomhed, da der jo er Omstændigheder, som taler for en Tiltagen af Kalkmængden ved Kysterne.

I Station 256, hvor Overfladevandets Saltstyrke er reduceret til 2.02 pCt., viser dog Forholdet mellem Bestanddelene saa smaa Afvigelser fra det almindelige, at disse fuldstændig kan forklares som Feil i Bestemmelserne, der ved Vandets Fortynding naturligvis taber i Nøiagtighed.

Kjender man Søvandets Klorgehalt, vil man af de i Tabellerne angivne Forholdstal kunne beregne de øvrige Bestanddele med saa stor Nøiagtighed, at de fundne Tal for Kalk, Magnesia og Svovlsyre kun undtagelsesvis vil differere mere end 0.002, 0.005 og 0.003 pCt. fra de direkte Bestemmelser i Tabel I.

Forat lette Sammenligningen med de tidligere Analyser har jeg i efterfølgende Tabel paa samme Vis som Forchhammer forbundet Klor og Svovlsyre med Kalk og Magnesia til de Salte, som i Almindelighed antages at forekomme i Søvandet. Al Kalk er regnet til Svovlsyre,

tain a larger quantity of sulphuric acid, since he found the proportion of that constituent between the 60th and 62nd parallels of latitude to be 0.230 per cent. But, in all probability, this incongruous result must be ascribed to a constant error in his analyses, precipitating as he did the sulphuric acid with nitrate of baryta, which — as will be afterwards shown — gives a much contaminated deposit.

From the last Table, it is sufficiently clear, that howsoever these determinations be regarded, they cannot be assumed to furnish absolute proof of a variable relation subsisting between the constituent parts of sea-water; and we must bear in mind, that of such differences as have hitherto defied the penetration of observers, the most striking refer to sulphuric acid determinations.

The hypothesis which assumes the Ocean to consist throughout its entire depth of one homogeneous fluid, in which the most accurate of chemical analyses shall fail to detect dissimilarity of composition, has received from the experiments here described probably stronger confirmation than from any that have gone before them. Indeed none of my own results exhibit a want of agreement so considerable as that met with in some of Forchhammer's and other chemists' analyses.

Again, passing to the diluted samples (with a specific gravity under 1.0260), no disturbance will be apparent in the constant relation subsisting between the component parts of the water. At Stations 300, 339, and 350, where the specific gravity and the proportion of chlorine are reduced by the melting, in the immediate vicinity, of large masses of ice, the other constituents exhibit a corresponding difference in amount. In two samples drawn at Station 143, in close proximity to the Norwegian coast, where the surface-water is accordingly somewhat diluted, I determined a comparatively large amount of lime, whereas the proportion of magnesia and sulphuric acid was in strict proportion to that of the chlorine. This result is, perhaps, deserving of notice, inasmuch as there are grounds for assuming the amount of lime to increase near the coast.

At Station 256, where the proportion of salt in the surface-water is reduced to 2.02 per cent, the disturbance in the normal relation subsisting between the several constituents was so slight, that it could be wholly accounted for in each case as an error of analysis, the determinations being by reason of the dilution of the water proportionately less accurate.

Given the amount of chlorine in sea-water, the other constituents may be calculated from the proportional values given in the Tables with such accuracy, that the figures found for lime, magnesia, and sulphuric acid will rarely differ more than 0.002, 0.005, and 0.003 per cent from the direct determinations set forth in Table I.

With a view to facilitate comparison with the earlier analyses, I have in the annexed Table, following the example of Forchhammer, combined chlorine and sulphuric acid with lime and magnesia, to form the salts which are generally assumed to occur in sea-water. Thus, all lime is

den tiloversblevne Svovlsyre til Magnesia, Resten af Magnesia og den hele Mængde Kali til Klor.

No.	$CaSO_4$.	$MgSO_4$.	$MgCl_2$.	KCl.	No.	$CaSO_4$.	$MgSO_4$.	$MgCl_2$.	KCl.
1	0.1454	0.2021	0.3651		26	0.1440	0.2059	0.3690	
2	0.1391	0.2136	0.3676		27	0.0757	0.1201	0.1945	
3	0.1396	0.2056	0.3591		28	0.1418	0.2029	0.3581	0.0716
4	0.1420	0.2157	0.3645		29	0.1424	0.2025	0.3667	0.0781
5	0.1374	0.2152	0.3497		30	0.1372	0.2134	0.3465	
6	0.1389	0.2121	0.3550	0.0751	31	0.1418			
7	0.1408				32	0.1384			
8	0.1396	0.2053	0.3546		33	0.1432	0.2089	0.3524	
9	0.1442	0.2058	0.3619		34	0.1436	0.2050	0.3678	
10	0.1394	0.2065	0.3543		35	0.1424	0.2073	0.3567	
11	0.1433	0.1961	0.3515		36	0.1403	0.2062	0.3538	0.0764
12	0.1389	0.2104	0.3629		37	0.1408	0.2049	0.3610	
13	0.1442	0.2059	0.3690		38	0.1440	0.2004	0.3674	
14	0.1360				39	0.1338	0.1905	0.3329	
15	0.1389	0.2082	0.3622		40	0.1399	0.2043	0.3496	
16	0.1401				41	0.1401	0.2091	0.3664	
17	0.1424				42	0.1425	0.1984	0.3602	
18	0.1364				43	0.1423	0.2119	0.3545	
19	0.1423	0.2083	0.3512		44	0.1345	0.1993	0.3420	
20	0.1396	0.2074	0.3486		45	0.1372	0.2059	0.3524	
21	0.1452	0.2058	0.3600	0.0755	46	0.1367	0.2101	0.3545	
22	0.1384	0.2086	0.3669		47	0.1391	0.2062	0.3650	
23	0.1430	0.2034	0.3629		48	0.1384	0.2004	0.3448	
24	0.1413	0.2076	0.3700		49	0.1408	0.2081	0.3472	
25	0.1423	0.2083	0.3481		50	0.1422	0.2067	0.3505	0.0720
					51	0.1396	0.2088	0.3643	

Beregner man efter den sidste Tabel Klornatriumgehalten af den Klormængde, der er blevet tilovers fra Kali og Magnesia, og adderes derpaa Salterne sammen, vil man finde, at Summen bliver noget lavere end de Tal, der i Tabel I angiver Vandets samlede Saltmængde. Den Natriumgehalt, der erholdes ved denne Beregning bliver nemlig for liden, da der ikke er taget noget Hensyn til de i mindre Mængde forekommende Syrer.

Den vigtigste af disse skulde ifølge Hr. Tornøes Undersøgelser være den af Baserne bundne Kulsyre. Da Tornøe har bestemt denne Bestanddel i de samme Vandprøver, hvori jeg senere har udført mine Analyser, har jeg medtaget de af ham fundne Kulsyremængder ved følgende Beregning af Søvandets Bestanddele, ved hvilken jeg tillige har opført den Klornatriumsgehalt, der svarer til det tiloversblevne Klor. I Overensstemmelse med hvad der forud er sagt, har jeg forenet den surtbundne Kulsyre med Natron til dobbelt kulsurt Salt. Den tiloversblevne ringe Mængde neutraltbundne Kulsyre har jeg regnet til Kalk. Ved Siden af den Sum, der erholdes ved Addition af samtlige Bestanddele, har jeg opført den Saltgehalt, der er fundet ved Inddampning af Søvandet efter den forud beskrevne Methode.

combined with sulphuric acid; the surplus of sulphuric acid, with magnesia; the surplus of magnesia and the whole amount of potash, with chlorine.

No.	$CaSO_4$.	$MgSO_4$.	$MgCl_2$.	KCl.	No.	$CaSO_4$.	$MgSO_4$.	$MgCl_2$.	KCl.
1	0.1454	0.2021	0.3651		26	0.1440	0.2059	0.3690	
2	0.1391	0.2136	0.3676		27	0.0757	0.1201	0.1945	
3	0.1396	0.2056	0.3591		28	0.1418	0.2029	0.3581	0.0716
4	0.1420	0.2157	0.3645		29	0.1424	0.2025	0.3667	0.0781
5	0.1374	0.2152	0.3497		30	0.1372	0.2134	0.3465	
6	0.1389	0.2121	0.3550	0.0751	31	0.1418			
7	0.1408				32	0.1384			
8	0.1396	0.2053	0.3546		33	0.1432	0.2089	0.3524	
9	0.1442	0.2058	0.3619		34	0.1436	0.2050	0.3678	
10	0.1394	0.2065	0.3543		35	0.1424	0.2073	0.3567	
11	0.1433	0.1961	0.3515		36	0.1403	0.2062	0.3538	0.0764
12	0.1389	0.2104	0.3629		37	0.1408	0.2049	0.3610	
13	0.1442	0.2059	0.3690		38	0.1440	0.2004	0.3674	
14	0.1360				39	0.1338	0.1905	0.3329	
15	0.1389	0.2082	0.3622		40	0.1399	0.2043	0.3496	
16	0.1401				41	0.1401	0.2091	0.3664	
17	0.1424				42	0.1425	0.1984	0.3602	
18	0.1364				43	0.1423	0.2119	0.3545	
19	0.1423	0.2083	0.3512		44	0.1345	0.1993	0.3420	
20	0.1396	0.2074	0.3486		45	0.1372	0.2059	0.3524	
21	0.1452	0.2058	0.3600	0.0755	46	0.1367	0.2101	0.3545	
22	0.1384	0.2086	0.3669		47	0.1391	0.2062	0.3650	
23	0.1430	0.2034	0.3629		48	0.1384	0.2004	0.3448	
24	0.1413	0.2076	0.3700		49	0.1408	0.2081	0.3472	
25	0.1423	0.2083	0.3481		50	0.1422	0.2067	0.3505	0.0720
					51	0.1396	0.2088	0.3643	

Now, on computing by the last Table the amount of chloride of sodium from the surplus proportion of chlorine, uncombined with potash and magnesia, and then adding together the results, the total will be somewhat less than the whole amount of salt in sea-water as given in Table I — and for this reason, that the proportion of sodium thus computed is too small, no regard having been had to the acids occurring in small quantities in sea-water.

The most important of these, according to Mr. Tornøe's observations, is carbonic acid united to bases. Mr. Tornøe having determined this constituent in the same samples that I subsequently examined, I have taken his carbonic acid values for the following computation of the constituent parts of sea-water, among which I have given the amount of chloride of sodium corresponding to the surplus of chlorine. In conformity with what has been previously stated, I have combined the carbonic acid occurring in bicarbonates with soda, to form bicarbonate of soda. The small surplus of carbonic acid occurring in bicarbonates, I have combined with lime. Along with the total amount found by adding together the several constituents, I have given the proportion of salt obtained after evaporating sea-water by the method previously described.

No.	$CaCO_3$	$CaSO_4$	$MgSO_4$	$MgCl_2$	KCl	$NaHCO_3$	NaCl	Sum.	Saltgehalt.
21	0.0020	0.1423	0.2083	0.3581	0.0755	0.0175	2.691	3.49	3.49
28	0.0021	0.1389	0.2074	0.3558	0.0716	0.0157	2.670	3.46	3.49
29	0.0021	0.1396	0.2049	0.3645	0.0781	0.0165	2.678	3.48	3.51
36	0.0024	0.1370	0.2091	0.3509	0.0764	0.0164	2.694	3.49	3.51
50	0.0016	0.1399	0.2056	0.3515	0.0720	0.0170	2.678	3.46	3.47

Som Følge af den høiere Svovlsyregehalt, Forchhammer finder i Søvandet, bliver hans Tal for Klornatrium ogsaa noget forøget. I Vandprøver af samme Egenvægt og Saltgehalt, som de af mig undersøgte, erholder han som Middeltal 2.75 pCt. Klornatrium.

Efter Tabel III har det nordlige Ishav gjennemsnitlig en specifisk Vægt af 1.0265, og 100 Dele af Vandet indeholder:

CaO	MgO	K_2O	Cl	SO_3
0.0578	0.2203	0.0472	1.932	0.2214.

Som Middeltal for de i Havet forekommende Salte erholdes ifølge den sidste Tabel:

$CaCO_3$	$CaSO_4$	$MgSO_4$	$MgCl_2$	KCl	$NaHCO_3$	NaCl
0.002	0.1395	0.2071	0.3561	0.0747	0.0166	2.682

100 Dele af det faste Søsalt indeholder altsaa:

$CaCO_3$	$CaSO_4$	$MgSO_4$	$MgCl_2$	KCl	$NaCO_3$	NaCl
0.057	4.00	5.93	10.20	2.14	0.475	76.84.

Til Slutning vil jeg udtale min hjerteligste Tak til Hr. Professor Waage for den Hjælp, han paa flere Steder i mine Undersøgelser har ydet mig.

Kristiania, den 14de Februar 1880.

No.	$CaCO_3$	$CaSO_4$	$MgSO_4$	$MgCl_2$	KCl	$NaHCO_3$	NaCl	Total.	Prop. of Salt.
21	0.0020	0.1423	0.2083	0.3581	0.0755	0.0175	2.691	3.49	3.49
28	0.0021	0.1389	0.2074	0.3558	0.0716	0.0157	2.670	3.46	3.49
29	0.0021	0.1396	0.2049	0.3645	0.0781	0.0165	2.678	3.48	3.51
36	0.0024	0.1370	0.2091	0.3509	0.0764	0.0164	2.694	3.49	3.51
50	0.0016	0.1399	0.2056	0.3515	0.0720	0.0170	2.678	3.46	3.47

By reason of the greater proportion of sulphuric acid Forchhammer found in sea-water, his figures for chloride of sodium are neccessarily somewhat higher. In samples of water with precisely the same amount of salt as those examined by myself, he determined the mean proportion of chloride of sodium to be 2.75 per cent.

According to Table III, the specific gravity of the Norwegian Sea is 1.0265; and 100 parts of the water contain —

CaO	MgO	K_2O	Cl	SO_3
0.0577	0.2203	0.0472	1.932	0.2214.

The mean values, as computed by the last Table, for the salts occurring in ocean-water, are as follows: —

$CaCO_3$	$CaSO_4$	$MgSO_4$	$MgCl_2$	KCl	$NaHCO_3$	NCl
0.002	0.1395	0.2071	0.3561	0.0747	0.0166	2.682.

Hence, 100 parts of dry sea-salt contain —

$CaCO_3$	$CaSO_4$	$MgSO_4$	$MgCl_2$	KCl	$NaCO_3$	NaCl
0.057	4.00	5.93	10.20	2.14	0.475	76.84.

In conclusion, I beg to return Professor Waage my most sincere thanks for the assistance he kindly rendered me when instituting the observations recorded in this Memoir.

Christiania, Febr. 14th 1880.

Om Havbundens Afleiringer.

Blandt de mange videnskabelige Undersøgelser, der behandler Havets forskjellige Naturforhold, findes der kun faa, som har skaffet os nogen Kundskab om den kemisk-geologiske Beskaffenhed af de Afleiringer, der bedækker Bunden i de store Havbasiner.

Det kan neppe vække nogen Forundring, at vore Erfaringer i denne Retning endnu er meget begrændsede, naar vi erindrer, hvilke betydelige Hjælpemidler, der er nødvendige for at gjøre Havbunden paa de dybere Steder tilgjængelig for den videnskabelige Forskning.

Der er vistnok i Tidernes Løb samlet mange Bidrag til Læren om de Sedimenter, der har afleiret sig langs Kysterne i de grundere Dele af Havet,[1] men ved Mangel paa Materiale har vi været forhindrede fra at gjøre os noget klart Begreb om de lignende Dannelser i Oceanets store Dyb.

De mange videnskabelige Expeditioner, dér har undersøgt Havet i forskjellige Retninger, har tildels ogsaa hentet Prøver op af Havbunden, men Observationerne dreier sig væsentlig om deres zoologiske Forhold.[2]

En planmæssig og alsidig Undersøgelse af Havbunden er først blevet iværksat af den britiske "Challenger"-Expedition (1872—1876). Det rige Materiale af Bundprøver, der ved denne Anledning er indsamlet, er endnu ikke paa langt nær bearbeidet, men Expeditionens foreløbige Meddelelser — ved Sir Wywille Thomson og Mr. John Murray[3] — har allerede vist os store og overraskende Resultater.

[1] Det mest omfattende Værk i denne Retning er: „Lithologie du fond des mers" par M. Delesse.

[2] Dr. Wallich: The North-Atlantic Sea-Bed. Preliminary Report of the Scientific Exploration of the Deep Sea in H. M. Surveying Vessel "Porcupine". 1869. (Being No. 121 of the Proceedings of the Royal Society). The "Valorous" Expedition. Reports by Dr. Gwyn Jeffreys and Dr. Carpenter. (From the Proceedings of the Royal Society, Vol. XXV, No. 173).

[3] Reports from the "Challenger". (From the Proceedings of the Royal Society, No. 107, 1868). "The Atlantic" by Sir Wyville Thomson.

On Oceanic Deposits.

Of the numerous scientific investigations undertaken to determine the physical conditions of the sea, very few have furnished us with trustworthy data concerning the chemico-geological nature of the deposits in the great ocean basins.

Nor is it surprising that our experience in that direction should as yet be very limited, if we call to mind by what elaborate and costly means the bed of the ocean can alone be rendered accessible to scientific research.

True, many valuable additions have from time to time been made to our knowledge of the sea-bottom and its surface-stratum of sedimentary matter in coastal localities where the water is comparatively shallow;[1] but no clear idea could, for want of samples, be formed of the deposits in the great depths of the ocean.

On one or two of the many scientific Expeditions despatched to investigate the sea in different parts of the world, samples of the bottom were indeed collected, though chiefly as a help towards determining, from the character of any organisms they might contain, the general biological features of the region explored.[2]

A systematic and comprehensive investigation of the ocean-bed was first attempted on the "Challenger" Expedition (1872—76). Much still remains to be done in working out its rich collection of samples; but the Preliminary Reports of Sir Wyville Thomson and Mr. John Murray[3] sufficiently attest that great and surprising results have been attained.

[1] The most comprehensive work on this subject is "Lithologie du fond des mers," by M. Delesse.

[2] Dr. Wallich: The North-Atlantic Sea-Bed. Preliminary Report of the Scientific Exploration of the Deep Sea in H. M. Surveying Vessel "Porcupine," 1869. (Being No. 121 of the Proceedings of the Royal Society). The "Valorous" Expedition. Reports by Dr. Gwyn Jeffreys and Dr. Carpenter. (From the Proceedings of the Royal Society, Vol. XXV, No. 173.)

[3] Reports from the "Challenger." (From the Proceedings of the Royal Society, No. 107, 1868.) "The Atlantic," by Sir Wyville Thomson.

Det europæiske Nordhav, der 1876, 1877 og 1878 var Gjenstand for den norske Expeditions Undersogelser, kan i Udstrækning ikke maale sig med de store Verdenshave; men det frembyder ved sin Beliggenhed en i flere Retninger særegen Interesse.

Dette gjælder ikke mindst om dets geologiske Forhold. Naar vi tager disse i Betragtning, maa vi kunne gjøre os et Begreb om enkelte af de Betingelser, der er givne for Dannelsen af Bundens Afleiringer i dette Hav.

Vi finder det fra forskjellige Sider begrændset af Øer og Kontinenter, hvor glaciale og vulkanske Kræfter har været og endnu er i Virksomhed. Norge er vel et af de Lande, der fortrinsvis har været udsat for Istidens furende og afgnavende Evne, og Spidsbergen og Grønland befinder sig endnu i den glaciale Tilstand.

Medens vi altsaa i disse Lande kan iagttage Isens Virkninger i den nuværende og i den forbigangne Tid, har vi paa Øerne Island og Jan Mayen de vulkanske Kræfter repræsenterede i et lignende historisk Forhold. Jan Mayen er et nedlagt Værksted, hvor der ikke paa mange hundrede Aar har fundet noget større Udbrud Sted, men Islands Vulkaner fortsætter fremdeles sin Virksomhed.

Skjønt vi nu vanskelig kan gjøre os nogen Ide om, i hvor hoi Grad de ovennævnte Naturkræfter kan bidrage til Havets Afleiringer, ved vi dog, at de begge spiller en medvirkende Rolle. Det er saaledes almindelig bekjendt, hvorledes Isen — understøttet af Bræelvene — formaar at bære det Materiale, den har erobret fra det faste Land, ud i Havet. Her naar den som Drivis ud til de fjerneste Egne. Det er ogsaa en Nodvendighed, at der ved Vulkanernes Virksomhed maa samle sig mange mineralske Stoffe paa Havbunden. At disse kan være af væsentlig Betydning for dens Afleiringer er — for de store Verdenshaves Vedkommende — godtgjort ved Mr. Murrays Undersøgelser.

Foruden de ovennævnte Kræfter har vi i Nordhavet ogsaa andre, der i fremtrædende Grad virker i den samme Retning. Beeren Eiland er saaledes et mærkelig Exempel paa, hvorledes Bølgerne til Fordel for Havets Sedimenter formaar at udgrave og afslide det faste Land.

Ved Betragtning af disse mest ioinefaldende Naturforhold kan vi gjøre os et Begreb om, hvorledes der udenfra kan tilføres Havet Materiale, men paa den anden Side ved vi ogsaa, at Dyrelivet ved sine kemiske Virkninger kan give mægtige Bidrag til de sedimentære Nydannelser. Hvorledes nu de forskjellige Kræfter virker i Forening, hvem der har en større og hvem der har en mindre Betydning, og hvad der er det endelige Resultat af deres Samvirken — er Spørgsmaal, som vi ikke kan besvare, forend vi har hentet Materialet til vor Undersøgelse op fra selve Havbunden.

Ifølge Planen for den norske Nordhavsexpedition var der bestemt, at der paa alle de Stationer, hvor Dybdemaalinger foretoges, tillige skulde optages Prøver fra Bunden. For at anskueliggjøre de Redskaber, der tjente til

The Seas of Northern Europe scientifically investigated on the Norwegian Expedition in 1876, 1877, and 1878, though in point of extent they cannot compare with the great oceans of the globe, are yet, by reason of their geographical position, in many respects peculiarly attractive as a field of exploratory research.

And not least does this apply to their geological character, which, if rightly apprehended, cannot but afford a clew to some of the conditions determining the formation of sedimentary deposit over the bed of the North Atlantic.

The tract in question is bounded on several sides by islands and continents where glacial and volcanic agency has been and still continues in operation. Few regions of our planet can in like degree with Norway have been exposed to the furrowing and grinding action of glaciers during the great ice age; and Spitzbergen and Greenland are even now in a glacial state.

Thus, whilst the past and present effects of glacial action may be observed in those regions, the islands of Jan Mayen and Iceland exhibit a similar historic relation as regards volcanic agency. The former is, so to speak, a long since abandoned workshop, in which for hundreds of years there has been no considerable eruption, whereas the volcanoes of Iceland continue as active as ever.

Now, though we can hardly determine in what degree the said forces tend to increase oceanic deposits, we know that both play a co-operative part in their formation. Thus, for instance, it is a well-known fact, that the ice, in conjunction with glacier torrents, bears down all manner of *débris* to the ocean. From here it find its way as drift-ice to the most distant regions. Moreover, it is obvious that to volcanic agency must be ascribed the occurrence of many mineral substances present in oceanic deposit, of which they are shown by the results of Mr. Murray's investigations — as regards at least the great ocean basins — to constitute an important feature.

But, apart from the action of glaciers and volcanoes, we have other potent forces operating with like effect in the North Atlantic. Thus, Beeren Eiland signally exemplifies the remarkable instrumentality of the waves in accumulating sedimentary deposit over the ocean-bed by excavating and wearing away the rocks of the shore.

A glance at these salient physical conditions will suffice to show from what extraneous sources oceanic deposit can be derived; and on the other hand, we know that animal life, so abundant in the waters of the sea, must largely contribute to such new formations. But how the several forces act in conjunction, what is the product of each, and what the joint result of their co-operation, — these are questions the bearing of which we cannot venture to infer till such time as samples of deposit shall have been brought up from the sea-bed itself.

Pursuant to the Scheme of Work for the Norwegian North-Atlantic Expedition, a sample of the bottom was, if possible, to be obtained at every sounding-station. The following extracts from "The Apparatus, and how used," one

Indsamlingen af Bundprøverne, hidsætter jeg følgende Uddrag af Hr. Kaptein Willes Beretning om Apparaterne og deres Brug:

„Naar Dybden ikke antoges at være over 1000 Favne anvendtes det saakaldte Rørlod. Til Lodning paa større Dyb brugtes Baillie-Maskinen.

Rørloddet er af Bly (0.77^m langt og 0.078^m i Diameter) og veier 56 Kgr. Det har i den nedre Ende et i en Messingmuffe indskruet Jernrør (0.23^m langt og 0.04^m i indre Diameter) til Optagelse af Prøver fra Bunden. Dette Rør har i den øvre Ende nogle Huller, for at Vandet kan slippe ud, naar Bundprøven trænger ind nedenfra, og i den nedre Ende en Butterfly-Ventil, der aabner sig opad, og som hindrer Bundprøven fra at skylles ud under Ophalingen. Naar Røret er afskruet, kan et Sidestykke tages ud, hvorved Bundprøven kommer tilsyne med sine naturlige Lag og kan undersøges foreløbig, førend den bringes paa de dertil bestemte Opbevaringskar.

Til Oplodning paa over 1000 Favne brugtes Baillie-Maskinen, der var forsynet med den samme Indretning til Optagelse af Bundprøverne som Rørloddet; men Jernrøret var her betydelig større (0.43^m langt og 0.057^m indre Diameter) og kunde derfor skaffe rigeligere Portioner op af Havbunden“.

Hvor Slamlagene var mægtige nok til at fylde Jernrørene i hele deres Længde, kunde Rørloddet og Baillie-Maskinen optage 200—700 Gr.[1] af Havbundens løse Materiale.

Ombord blev der ikke foretaget nogen grundigere Undersøgelse af Bundprøverne. Man indskrænkede sig til korte Notitser i Loddejournalen om deres Udseende og Art, hvorpaa de opbevaredes paa Glaskrukker til videre Bearbeidelse efter Hjemkomsten. De Benævnelser, der ombord blev tildelt de forskjellige Slags Sedimenter, er væsentlig hydrografiske; de nye Udtryk, der er komne til, skyldes Zoologerne. Ved den kortfattede Beskrivelse i Loddejournalen har der imidlertid indsneget sig enkelte Misforstaaelser og Feil, som ved denne Afhandling vil blive Gjenstand for en Revision.

Det fremgik som et umiddelbart Resultat af Observationerne ombord, at de Slamdannelser, der bedækker Bunden i Nordhavet, er af en uligeartet Beskaffenhed.

Vi fandt imidlertid som en Lovmæssighed, at Bundprøverne kunde inddeles i forskjellige Grupper, hvis særegne Kjendemærker rettede sig efter Forekomststedet. I Overensstemmelse med hvad der er forud bekjendt om lignende Forhold, viste det sig, at Dybden var den væsentligste Betingelse for Sedimenternes Udseende og Art.

Jeg finder det hensigtsmæssigt, førend jeg gaar over til den nærmere Beskrivelse af Bundprøverne, at give en

[1] Vægten af Slammet i tørret Tilstand.

of Captain Wille's contributions to the General Report, are given to explain the character of the apparatus with which the samples were brought up.

"When the depth was supposed not to exceed 1000 fathoms, we used the tube-lead, as it is called. For sounding in greater depths the Baillie machine was employed.

The tube-lead (2 feet 6½ inches long by 3 inches in diameter) is of lead, and weighs 112 pounds. At the lower end it has a brass box, into which is screwed an iron tube, 9 inches long and 2 inches in diameter, for bringing up samples of the bottom. This tube has the upper end perforated with a number of holes to allow of the water passing out on the sample of the bottom pressing in from beneath, and is furnished at the lower end with a butterfly valve, opening inwards, to prevent the washing out of the sample on its journey to the surface. The tube screwed off, the sample within may, by removing a slip from the side, be disclosed as it lies *in situ* for preliminary examination, before being taken to the receptacles in which it is stored.

The Baillie machine, used for depths exceeding 1000 fathoms, had the same arrangement as the tube-lead for bringing up samples of the bottom; but the tube being of much greater dimensions (17 in. long by 2.2 in. in diameter), a proportionally larger quantum of deposit could be obtained with this instrument."

When the surface-layer was sufficiently extensive in a vertical direction to admit of the tubes being filled throughout their entire length, the tube-lead and the Baillie machine brought up respectively 200 grammes and 700 grammes[1] of the bottom.

On board, the samples were not submitted to analysis, but, after noting their nature and general appearance, carefully removed to glass jars for subsequent examination. The characteristic terms given in the sounding-journal to the various descriptions of clay, are chiefly hydrographic; for the various appellative expressions of zoological origin occurring in this Memoir I am indebted to the suggestions of Professor Sars and the other naturalists to the Expedition. Owing to the compendious form, a few minor errors and misconceptions have slipped into the brief descriptive statement in the sounding-journal, which has accordingly been submitted to a careful revision.

As a direct result of the cursory inspection on board, it was apparent that the layers of sedimentary deposit covering the bed of the North Atlantic differ considerably in character.

Meanwhile, a marked regularity of occurrence admitted of arranging the samples in definite groups, with distinctive features exclusively referrable to locality. In accordance with analogous phenomena previously investigated, depth proved the main condition determining the nature and appearance of the deposits.

Before proceeding to give a detailed description of the samples of the bottom collected on the Norwegian North-

[1] Weight of the clay when dried.

kortfattet Oversigt over de forskjellige Sedimenters Fordeling i Havet — støttet til Iagttagelserne ombord og mine senere Undersøgelser.

Jeg maa her forudskikke den Bemærkning, at jeg i Mangel af andre Udtryk har valgt Benævnelsen "Ler" for alle de Slamdannelser, der efter Tørring opnaaede en vis Fasthed og Sammenhængskraft. Beskrivelsen af Bundprøvernes ydre Kjendetegn refererer sig væsentlig til deres Udseende i den tørrede Tilstand, saaledes som jeg ved mine Undersøgelser har havt dem. Det være foreløbig sagt, at det mest karakteristiske Mærke for de forskjellige Sedimenter er Farven, der væsentlig er betinget af den Oxydationsgrad, hvori de befinder sig.

I de grundere Dele af Havbunden langs Norges og Spidsbergens Kyster finder vi Bunden bedækket af et mere eller mindre plastisk Ler, der næsten altid er af en graa Farve. Blandingsdelenes Finhed og Biblandingen af grovere Materiale — i Form af Sand, Dyreskaller og lignende — er meget forskjellige i de talrige Prøver, der er indsamlede fra disse Egne af Havbunden. Dette Kystler gaar sjelden dybere ned end til 400—500 Favne (700—900 Meter).

Ved dette Dyb støder man ialmindelighed paa et brunt Ler, der bebuder Overgangen til det egentlige Oceansediment. I Begyndelsen af sin Optræden er dette brune Ler ofte temmelig sandholdigt og grovkornigt og indeholder kun faa Foraminiferer (Overgangsler); længere ud i Havet bliver det mere fint og ensartet, indtil det gaar over i det saakaldte "Biloculinler", som findes paa næsten alle Dybder, der er større end 1000 Favne.

Dette er et eiendommeligt, fint Sediment af en lysbrun til mørkbrun Farve og udmærker sig ved sin større eller mindre Rigdom paa smaa Foraminiferer. Fremtrædende for det blottede Øie er især deleshed Slægten *Biloculina* med sine smaa hvide Skaller, af Størrelse og Form som et Knappenaalshoved, spredte rundt omkring i Slammet. Dette er derfor af Zoologerne opkaldt efter disse smaa Dyr, der giver det et karakteristisk og let kjendeligt Udseende.

Vi skal senere tale om de øvrige i Leret forekommende Foraminiferer, som paa Grund af sit Udseende eller sin ringe Størrelse er mindre iøinefaldende end Biloculinerne, om de end i Antal er langt overveiende.

I den østlige Del af Nordhavet mellem Spidsbergen, Beeren Eiland, Norge og Novaja Semlja har vi fundet Bunden bedækket med et grøn-graat paa Dyrelevninger fattigt Ler. Dets grønlige Farve og øvrige karakteristiske Egenskaber er især deleshed udprægede i Bundprøverne fra de østligste Stationer. Zoologerne har kaldt dette Sediment

Atlantic Expedition, I will briefly state the results of the preliminary inspection and my own subsequent examination in so far as they bear on the distribution of the deposits over the bed of the ocean-tract explored.

To begin with, I must observe that for want of some other, more precise expression, I have chosen the term "clay" by which to designate all sedimentary deposits that, when free from moisture, still retain a certain degree of firmness and cohesive power. My description of the external characteristics of the samples refers chiefly to their appearance when dry, in which state they were submitted to analysis. I may observe here, that colour, mainly dependent on the degree of oxidation, constitutes the most salient distinctive feature of oceanic deposits.

In the shallower parts of the sea along the coasts of Norway and Spitzbergen we find the surface of the bottom covered with a more or less plastic clay, almost invariably grey in colour. The fineness of the substance composing it and the admixture of coarser particles, such as sand, pebbles, calcareous shells, varies very considerably in the numerous samples brought up from the sea-bed in those localities. This coastal clay is rarely met with farther down than 400—500 fathoms (700—900 metres).

At that depth the surface-layer of the bottom is generally found to consist of a brown clay, which announces transition to the true oceanic deposit. Where it first occurs, this brown clay, containing but few Foraminifera (transition clay), is often more or less sabulous and coarsely granulated; but farther down it gets finer and more homogeneous in substance, till it is ultimately merged into that sedimentary deposit to which our naturalists have given the name of "Biloculina clay," met with at almost all depths exceeding 1000 fathoms.

Biloculina clay is a fine deposit varying in colour from light to dark brown, and distinguished by a greater or less abundance of minute Foraminifera. Of those perceptible to the naked eye, by far the greater part belong to the genus *Biloculina*, with its minute white shells, resembling a pin's head in size and shape, dispersed throughout the sedimentary substance, to which these small animals give a characteristic and easily recognisable appearance; — whence the appropriate name suggested by the naturalists to the Expedition.

We shall afterwards speak of the other Foraminifera that occur in this clay, but which, owing either to their appearance or minute size, are less conspicuous than the *Biloculinæ*, though greatly exceeding those animals in number.

In the eastern tract of the Arctic ocean between Spitzbergen, Beeren Eiland, and Novaja Zemlja, we found the bottom covered with a greenish-grey clay, containing but few animal remains. Its green colour and other distinctive features are particularly prominent in the samples collected at the most easterly of the observing-stations.

„Rhabdammina-Ler" efter en Foraminifer, som ofte forekommer paa denne Del af Havbunden.

Rundt omkring den vulkanske Ø Jan Mayen bestaar Bundens Afleiringer af et graasort fint Sand eller Sandler, der indeholder talrige Brudstykker af den basaltiske Lavas Mineraler.

Expeditionens Dybdemaalinger langs Islands Østkyst viste, at Bunden her var af en noget uligeartet Beskaffenhed. Selv paa de større Dyb (indtil 844 Favne) stødte Loddet flere Gange mod Sten og kom op uden nogen Bundprøve. Ved de nordlige Stationer paa denne Rute fandtes et mørkgraat Ler, paa de sydlige syntes Sand og Sten at være fremherskende.

Efter disse forelobige Meddelelser vil jeg nu give en ordnet Fortegnelse over det foreliggende Materiale, i hvilken man vil finde en kortfattet Beskrivelse af Bundprøvernes Udseende og Art. Hvad der i det foregaaende er sagt om Slamarternes Udbredelse belyses nøiere af det vedføiede Kart, som i det følgende skal nærmere forklares. *Slamarterne er paa dette Kart betegnet hver med sin naturlige Farve.* Forat faa disse i Overensstemmelse med Virkeligheden har jeg ladet dem kopiere efter et Originalkart, malet med pulveriserede Bundprøver, udrørte i Gummivand.

De Stene, der fandtes i Bundprøverne, hvilke ligeledes er medtaget i følgende Fortegnelse, kunde naturligvis blot være af en ringe Størrelse. Hvor der paa Havbunden laa Stene, der var større end Aabningen af Jernrøret, hvormed Bundprøverne optoges, maatte dette ialmindelighed komme tomt op, og i Loddejournalen noteredes i saadanne Tilfælde: haard Bund, eller: Fjeld. Den sidste Benævnelse er dog ved senere Overveielse blevet afskaffet, da den lettelig kan lede til en Begrebsforvirring, forsaavidt som den fører Tanken hen paa større sammenhængende Stenmasser, hvis Nærværelse naturligvis ikke kan bevises derved, at Jernrøret kommer tomt op. Jeg har i dette Tilfælde benyttet Udtrykket: Stenbund.

De fleste af de Bundprøver, der er optagne paa Kystbankerne indenfor det graa Lers Omraade, indeholder Stene i vexlende Mængde og af forskjellig Størrelse. Mangengang udgjorde disse en væsentlig Del af Bundprøven, saaat denne i tørret Tilstand lignede et Konglomerat.

I Bundprøverne fra Biloculinleret fandtes ogsaa af og til enkelte Stene, især i den nordlige Del af Havet.

De større Stene, der optoges med Skraben eller Trawlen, blev ialmindelighed bestemte ombord af Hr. Professor Mohn, der velvillig har overladt mig sine Optegnelser; en Del blev først efter Hjemkomsten undersøgt.

Jeg vil her paa Forhaand gjøre opmærksom paa, at

This deposit our naturalists have termed "Rhabdammina Clay," after a genus of Foraminifera which often abounds in that part of the ocean-bed.

Off the volcanic island of Jan Mayen, the surface-layer of the bottom consists of a fine, dark-grey sand, or sabulous clay, containing numerous particles of basaltic lava.

The soundings taken along the east coast of Iceland show the bottom to be somewhat variable in character throughout that locality. Even in the greater depths (as far down as 844 fathoms, for instance) the lead repeatedly struck against rock or stone, and came up with the tube empty. At the northern Stations in this tract we found a bottom of dark-grey clay, whereas at the southern, sand and stone would seem to predominate.

I will now, after the above preliminary observations, give a List of the samples collected on the North-Atlantic Expedition, along with a brief description of their nature and appearance. What has already been stated concerning the distribution of the oceanic deposits treated of in this Memoir, the accompanying map, of which a detailed explanation will afterwards be given, more fully elucidates. *In this Map each section has the colour actually distinguishing the deposit it represents.* That the different colours might be as true as possible to nature, I had them copied from an original map coloured with pulverized samples of the bottom dissolved in gum-water.

The pebbles found in the samples of the bottom and included in the following List, could be naturally but of trifling magnitude. If, in the locality where a sounding was taken, the sea-bed was covered with stones larger than the opening of the iron tube with which the samples of the bottom were collected, the apparatus would as a general rule come up empty, in which case "hard bottom" or "rock" was entered in the sounding-journal. The term rock, however, I have seen fit, after mature consideration, to reject, since it might very naturally give rise to misunderstanding, and be taken to signify a connected mass of stone, whose existence there is of course nothing whatever to prove in the fact of the tube coming up without a sample of the bottom. The expression "bottom stony" is therefore substituted for "rock", as less liable to misconstruction.

Most of the samples collected on the coastal banks, where a grey clay predominates, contained pebbles varying in number and magnitude. Frequently indeed they constituted the principal part of the sample, which, when dry, resembled conglomerate in appearance.

A few pebbles occurred too in the samples of Biloculina clay, more especially those from the northern part of the ocean-tract explored.

The larger stones brought up in the dredge or trawl were as a rule determined on board by Professor Mohn, who has kindly placed his memoranda at my service; some few however were not examined till after the return of the Expedition.

With regard to my determination of the pebbles

Bestemmelsen af de smaa Stene, der blev fundne i Bundproverne, er udfort ganske overfladisk uden noiere mikroskopiske Undersogelser og derfor nodvendigvis maa betragtes med et vist Forbehold. Det vil saaledes forstaaes, at man ved Betragtning af disse smaa Brudstykker vanskelig skal kunne skjelne mellem de nærbeslægtede Bergarter (f. Ex. de forskjellige krystallinske Skifere), og endnu mindre lader det sig paa denne Maade afgjore, hvor deres oprindelige Forekomststed har været. En noiere Undersogelse med Hensyn til det sidste Sporgsmaal vilde visselig være af Interesse, men paa Grund af det omstændelige Arbeide, som hertil kræves, har jeg forelobig maattet sætte den tilside.

met with in the specimens of the bottom, I will state at once, that, having been roughly performed without the aid of the microscope, it does not pretend to more than comparative accuracy, and some reservation should accordingly be shown in receiving the results. It is no easy matter to distinguish at sight, when examining such small fragments, between different but closely resembling descriptions of rock (for instance the numerous crystalline schists), while the difficulty of thus determining their origin must be far greater, not to say insuperable. A closer examination with those objects in view would no doubt be well worth undertaking; but owing to the labour it would involve, I must await a more favourable opportunity for further investigations.

Bundprøver fra 1876.

Station 3. Nordlig Bredde 61° 5′, Østlig Længde fra Greenwich 5° 15′. Sognefjorden. Dybde 618 Favne (1130 Meter). Bundtemperatur 6.6°. En liden Prove af blaagraat og brungraat, sandholdigt Ler med nogle smaa Kvartskorn. Faa uorganiske Dyrelevninger.

Station 4. N. B. 61° 5′, Ø. L. 5° 14′. 566 Fvn. (1035 M.). 6.6°. Graat, sandholdigt Ler med mange ganske smaa Stene (veiende indtil 0.5 Gr.), væsentlig bestaaende af Kvarts.

Station 5. N. B. 61° 6′, Ø. L. 5° 12′ 504 Fvn. (922 M.). 6.6°. Graat sandholdigt Ler.

Station 6. N. B. 61° 6′, Ø. L. 5° 9′. 211 Fvn. (386 M.). 6.6°. Stenbund.

Station 7. N. B. 61° 6′, Ø. L. 5° 11′. 206 Fvn. (377 M.). 6.6°. Stenbund.

Station 9. N. B. 61° 30′, Ø. L. 3° 37′. 206 Fvn. (377 M.). 5.8°. Ensartet, lysgraat Ler. Ingen Stene. Mange uorganiske Dyrelevninger (især af Slægten *Urigerina*).

Station 10. N. B. 61° 41′, Ø. L. 3° 19′. 220 Fvn. (402 M.). 6.0°. Fint, ensartet, brunliggraat Ler. Ingen Stene. Faa uorganiske Dyrelevninger.

Station 11. N. B. 61° 47′, Ø. L. 3° 9′. 232 Fvn. (424 M.). 6.1°. Fint, graat Ler.

Samples of the Bottom (1876).

Station 3 (the Sognefjord). — Lat. 61° 5′ N., long. 5° 15′ E.; depth 618 fathoms (1130 metres); bottom-temperature 6.6°. A small sample of bluish-grey and brownish-grey sabulous clay containing granular fragments of quartz and a few inorganic animal remains.

Station 4. — Lat. 61° 5′ N., long. 5° 14′ E.; d. 566 fms. (1035 m.); b.-t. 6.6°. A grey sabulous clay containing numbers of very small pebbles, chiefly quartz, the biggest weighing 0.5 gr.

Station 5. — Lat. 61° 6′ N., long. 5° 12′ E.; d. 504 fms. (922 m.); b.-t. 6.6°. A grey, sabulous clay.

Station 6. — Lat. 61° 6′ N., long. 5° 9′ E.; d. 211 fms (386 m.); b.-t. 6.6°. Bottom stony.

Station 7. — Lat. 61° 6′ N., long. 5° 11′ E.; d. 206 fms. (377 m.); b.-t. 6.6°. Bottom stony.

Station 9. — Lat. 61° 30′ N., long. 3° 37′ E.; d. 206 fms. (377 m.); b.-t. 5.8°. A uniform, light-grey clay containing numerous inorganic animal remains (particularly of the genus *Urigerina*). No pebbles.

Station 10. — Lat. 61° 41′ N., long. 3° 19′ E.; d. 220 fms. (402 m.); b.-t. 6.0°. A uniformly fine, brownish-grey clay containing a few inorganic animal remains. No pebbles.

Station 11. — Lat. 61° 47′ N., long. 3° 9′ E.; d. 232 fms. (424 m.); b.-t. 6.1°. A fine, grey clay.

Station 12. N. B. 61° 53′, Ø. L. 3° 0′. 223 Fvn. (408 M.). 6.3°. Fint, graat Ler.

Station 13. N. B. 61° 58′, Ø. L. 2° 54′. 228 Fvn. (417 M.). 6.1°. Lysgraat, ensartet, finkornigt og fast Ler. Ingen Stene. Faa Kalkskaller.

Station 14. N. B. 62° 4′, Ø. L. 2° 45′. 226 Fvn. (413 M.). 6.1°. Graat, ensartet, grovkornigt Ler. Et lidet Stykke Jern, som muligens er afslidt Loddet. Ingen Stene. Mange Kalkskaller *(Urigerina)*.

Station 15. N. B. 62° 10′, Ø. L. 2° 36′. 221 Fvn. (404 M.). 6.1°. Graat, fint Ler.

Station 16. N. B. 62° 24′, Ø. L. 2° 17′. 221 Fvn. (404 M.). 4.6°. Stenbund.

Station 17. N. B. 62° 33′, Ø. L. 2° 4′. 288 Fvn. (527 M.). 2.4°. Stenbund.

Station 18. N. B. 62° 44′, Ø. L. 1° 48′. 412 Fvn. (753 M.). — 1.0°. Blanding af lysgraat Sandler og brunliggraat, fast og finkornigt Ler. I Bundprøven fandtes mange smaa Glimmerblade og afrundede Kvartskorn, men forøvrigt kun faa og ganske smaa Stene. Med Skraben optoges paa denne Station en stor, rund Sten, der viste sig at være en Breccie, en fin, graa Sandsten og en afrundet Marmorblok (0.25 M. lang og 0.15 M. bred). Efterat et Stykke var slaaet af den sidstnævnte Sten, flod der Vand ud af et Hul i dens Indre.

Station 19. N. B. 62° 23′, Ø. L. 2° 5.0′. 226 Fvn. (413 M.). 6.0°. Graat, sandholdigt Ler.

Station 20. N. B. 62° 16′, Ø. L. 3° 8′. 219 Fvn. (400 M.). 6.2°. Graat, grovkornigt og usammenhængende Ler tilligemed noget af en mørkere Slags. Ingen Stene. En Mængde Skaller af *Urigerina.*

Station 21. N. B. 62° 14′, Ø. L. 3° 28′. 188 Fvn. (344 M.). 5.8°. Graat, sandholdigt Ler.

Station 24. N. B. 63° 10′, Ø. L. 5° 58′. 90 Fvn. (165 M.). 6.9°. Graat, sandholdigt Ler.

Station 26 a. N. B. 63° 10′, Ø. L. 5° 16′. 237 Fvn. (433 M.). 7.1°. Graat, sandholdigt Ler.

Station 26 b. N. B. 63° 7′, Ø. L. 5° 17′. 90 Fvn. (165 M.). 7.8°. Stenbund.

Station 27. N. B. 63° 6′, Ø. L. 5° 18′. 90 Fvn. (165 M.). 7.8°. Stenbund.

Station 12. — Lat. 61° 53′ N., long. 3° 0′ E.; d. 223 fms. (408 m.); b.-t. 6.3°. A fine, grey clay.

Station 13. — Lat. 61° 58′ N., long. 2° 54′ E.; d. 228 fms. (417 m.); b.-t. 6.1°. A firm, finely granulous, light-grey clay containing a few calcareous shells. No pebbles.

Station 14. — Lat. 62° 4′ N., long. 2° 45′ E.; d. 226 fms. (413 m.); b.-t. 6.1°. A grey, coarsely granulous clay containing numbers of calcareous shells *(Urigerina)* and a particle of iron, possibly broken off one of the sinkers. No pebbles.

Station 15. — Lat. 62° 10′ N., long. 2° 36′ E.; d. 221 fms. (404 m.); b.-t. 6.1°. A fine, grey clay.

Station 16. — Lat. 62° 24′ N., long. 2° 17′ E.; d. 221 fms. (404 m.); b.-t. 4.6°. Bottom stony.

Station 17. — Lat. 62° 33′ N., long. 2° 4′ E.; d. 288 fms. (527 m.); b.-t. 2.4°. Bottom stony.

Station 18. — Lat. 62° 44′ N., long. 1° 48′ E.; d. 412 fms. (753 m.); b.-t. — 1.0°. A mixture of light-grey sabulous clay and brownish-grey, firm, and finely granulated clay containing numerous delicate laminæ of mica and globular granules of quartz, as also a few very small pebbles. The dredge brought up a big, round stone, which proved on inspection to be a breccie, together with a block of marble (0.25 m. long and 0.15 m. broad). On breaking off a piece of the latter, water was seen to well forth from an aperture in the side.

Station 19. — Lat. 62° 23′ N., long. 2° 5.0′ E.; d. 226 fms. (413 m.); b.-t. 6.0°. A grey, sabulous clay.

Station 20. — Lat. 62° 16′ N., long. 3° 8′ E.; d. 219 fms. (400 m.); b.-t. 6.2°. A grey coarsely granulous loose clay, along with a little of a darker tint containing countless shells of *Urigerina.* No pebbles.

Station 21. — Lat. 62° 14′ N., long. 3° 28′ E.; d. 219 fms. (344 m.); b.-t. 5.8°. A grey, sabulous clay.

Station 24. — Lat. 63° 10′ N., long. 5° 58′ E.; d. 90 fms. (165 m.); b.-t. 6.9°. A grey, sabulous clay.

Station 26 a. — Lat. 63° 10′ N., long. 5° 16′ E.; d. 237 fms. (433 m.); b.-t. 7.1°. A grey, sabulous clay.

Station 26 b. — Lat. 63° 7′ N., long. 5° 17′ E.; d. 90 fms. (165 m.); b.-t. 7.8°. Bottom stony.

Station 27. — Lat. 63° 6′ N., long. 5° 18′ E.; d. 90 fms. (165 m.); b.-t. 7.8°. Bottom stony.

Station 28. N. B. 63° 10′, Ø. L. 5° 11′. 396 Fvn. (724 M.). — 0.5°. Graat, sandholdigt Ler.

Station 29. N. B. 63° 10′, Ø. L. 5° 7′. 396 Fvn. (724 M.). — 0.2°. Graat, sandholdigt Ler.

Station 30. N. B. 63° 10′, Ø. L. 5° 4′. 401 Fvn. (733 M.). — 0.4°. Fint, ensartet, lysgraat Ler. Ingen Stene. Faa Kalkskaller.

Station 31. N. B. 63° 10′, Ø. L. 5° 0′. 417 Fvn. (763 M.). — 0.9°. Graat, sandholdigt Ler.

Station 32. N. B. 63° 10′, Ø. L. 4° 51′. 430 Fvn. (786 M.). — 0.6°. Graat, fint Ler. Mange Stene i Bundprøven (veiende indtil 2.5 Gr.), bestaaende af Kvartsskifer, Gneis. I Skraben fandtes: Rød Sandsten, grøn Lerskifer, Granit, *Pimpsten* (5 × 5 × 5 Cm.) og endel ubestemmelige forvitrende Stene. Faa Kalkskaller.

Station 33. N. B. 63° 5′, Ø. L. 3° 0′. 525 Fvn. (960 M.). — 1.1°. Graat Ler.

Station 34. N. B. 63° 5′, Ø. L. 0° 53′. 587 Fvn. (1073 M.). — 1.0°. Graat, fint Ler (Slik).

Station 35. N. B. 63° 7′, V. L. 1° 26′. 1081 Fvn. (1977 M.). — 1.0°. Biloculinler.

Station 36. N. B. 62° 15′, V. L. 4° 34′. 148 Fvn. (271 M.). 7.9°. Stenbund.

Station 37. N. B. 62° 28′, V. L. 2° 29′. 690 Fvn. (1226 M.). — 1.1°. Brunt, sandholdigt Ler. Nogle smaa Stene. Mange fine Glimmerblade.

Station 38. N. B. 63° 1′, V. L. 3° 58′. 204 Fvn. (373 M.). 0.7°. Stenbund.

Station 40. N. B. 63° 22′, V. L. 5° 29′. 1215 Fvn. (2222 M.). — 1.2°. Ensartet Biloculinler med mange Biloculiner. I Bundprøven ingen Stene. I Skraben fandtes: Et Stykke af en tæt Gneis, Klumper og Knoller af forskjellig Form, Størrelse og Farve og nogle Pimpstenstykker.

Station 41. N. B. 63° 37′, V. L. 7° 10′. 697 Fvn. (1275 M.). — 1.0°. Fint, graat, ensartet Ler. Ingen Stene.

Station 42. N. B. 63° 2′, V. L. 10° 17′. 264 Fvn. (483 M.). 1.3°. Stenbund.

Station 43. N. B. 63° 11′, V. L. 13° 32′. 529 Fvn. (967 M.). 2.9°. Lerholdigt Sand.

Station 28. — Lat. 63° 10′ N., long. 5° 11′ E.; d. 396 fms. (724 m.); b.-t. — 0.5°. A grey, sabulous clay.

Station 29. — Lat. 63° 10′ N., long. 5° 7′ E.; d. 396 fms. (724 m.); b.-t. — 0.2°. A grey, sabulous clay.

Station 30. — Lat. 63° 10′ N., long. 5° 4′ E.; d. 401 fms. (733 m.); b.-t. — 0.4°. A fine, uniform, light-grey clay containing a few calcareous shells. No pebbles.

Station 31. — Lat. 63° 10′ N., long. 5° 0′ E.; d. 417 fms. (763 m.); b.-t. — 0.9°. A grey, sabulous clay.

Station 32. — Lat. 63° 10′ N., long. 4° 51′ E.; d. 430 fms. (786 m.); b.-t. — 0.6°. A fine, grey clay containing: — Numerous pebbles of silicious schist and gneiss; fragments of red sandstone, green argillaceous slate, granite, *pumice* (5 × 5 × 5 cm); divers indeterminable disintegrated particles of stone; a few calcareous shells.

Station 33. — Lat. 63° 5′ N., long. 3° 0′ E.; d. 525 fms. (960 m.); b.-t. — 1.1°. A grey clay.

Station 34. — Lat. 63° 5′ N., long. 0° 53′ E.; d. 587 fms. (1073 m); b.-t. — 1.0°. A grey mud.

Station 35. — Lat. 63° 7′ N., long. 1° 26′ W.; d. 1081 fms. (1977 m.); b.-t. — 1.0°. Biloculina clay.

Station 36. — Lat. 62° 15′ N., long. 4° 34′ W.; d. 148 fms. (271 m.); b.-t. 7.9°. Bottom stony.

Station 37. — Lat. 62° 28′ N., long. 2° 29′ W.; d. 690 fms. (1226 m.); b.-t. — 1.1°. A brown, sabulous clay containing a few small pebbles and numerous delicate micaceous laminæ.

Station 38. — Lat. 63° 1′ N., long. 3° 58′ W.; d. 204 fms. (373 m.); b.-t. 0.7°. Bottom stony.

Station 40. — Lat. 63° 22′ N., long. 5° 29′ W.; d. 1215 fms. (2222 m.); b.-t. — 1.2°. A uniform biloculina clay containing many *Biloculinæ*. No pebbles. The dredge brought up a fragment of compact gneiss, together with numerous nodules, or concretions, varying in form, magnitude, and colour, and a few pieces of pumice.

Station 41. — Lat. 63° 37′ N., long. 7° 10′ W.; d. 697 fms. (1275 m.); b.-t. — 1.0°. A fine, grey, uniform clay. No pebbles.

Station 42. — Lat. 63° 2.5′ N., long. 10° 17′ W.; d. 264 fms. (483 m.); b.-t. 1.3°. Bottom stony.

Station 43. — Lat. 63° 11′ N., long. 13° 32′ W. d. 529 fms. (967 m.); b.-t. 2.9°. Argillaceous sand.

Station 44. N. B. 63° 8′. V. L. 14° 0′. 844 Fvn. (1543 M.). 2.7°. Stenbund.

Station 45. N. B. 63° 28′. V. L. 12° 58′. 381 Fvn. (997 M.). 4.3°. Stenbund; blot en liden Prøve af brunt, lerholdigt Sand. Mange ganske smaa Stene: Kalkspath.

Station 46. N. Br. 63° 51′. V. L. 12° 5′. 257 Fvn. (470 M.). 3.9°. Sten og graat Ler.

Station 47. N. B. 64° 13.5′. V. L. 11° 14′. 190 Fvn. (347 M.). 6.0°. Stenbund.

Station 48. N. B. 64° 36′. V. L. 10° 22′. 299 Fvn. (547 M.). — 0.3°. Ensartet, mørkgraat, løst Ler. Nogle Stene i Bundprøven: Kvarts, Granit (veiende indtil 0.1 Gr.). Faa Kalkskaller.

Station 49. N. B. 65° 0′. V. L. 9° 25′. 437 Fvn. (799 M.). — 0.8°. Sandholdigt Ler.

Station 50. N. B. 65° 26′. V. L. 8° 24′. 571 Fvn. (1044 M.). — 0.9°. Mørkt, blaaliggraat Ler. Ingen Stene.

Station 51. N. B. 65° 53′. V. L. 7° 18′. 1163 Fvn. (2127 M.). — 1.1°. Biloculinler. Ingen Stene.

Station 52. N. B. 65° 47′. V. L. 3° 7′. 1861 Fvn. (3403 M.). — 1.2°. Biloculinler. Ingen Stene.

Station 53. N. B. 65° 13′. Ø. L. 0° 33′. 1539 Fvn. (2814 M.). — 1.3°. Biloculinler. Paa hver □Cm. af den tørrede Bundprøve 2—3 Biloculiner. Ingen Stene.

Station 54. N. B. 64° 47′. Ø. L. 4° 24′. 601 Fvn. (1099 M.). — 1.2°. Biloculinler. En Mængde Globigeriner. Ingen Stene.

Station 55. N. B. 64° 38′. Ø. L. 10° 22′. 93 Fvn. (170 M.). 7.2°. Stenbund.

Station 56. N. B. 64° 39′. Ø. L. 10° 11′. 178 Fvn. (326 M.). 7.2°. Graat, finkornigt, sandholdigt, løst Ler. Temmelig faa uorganiske Dyrelevninger.

Station 57. N. B. 64° 39′. Ø. L. 9° 59′. 161 Fvn. (284 M.). 7.0°. Blaaliggraat, fint, fast Ler. Mange Stene (veiende indtil 1.5 Gr.), bestaaende af krystallinske Skifere. Ingen Kalkskaller.

Station 58. N. B. 64° 39′. Ø. L. 9° 49′. 221 Fvn.

Station 44. — Lat. 63° 8′ N., long. 14° 0′ W.; d. 844 fms. (1543 m.); b.-t. 2.7°. Bottom stony.

Station 45. — Lat. 63° 28′ N., long. 12° 58′ W.; d. 381 fms. (997 m.); b.-t. 4.3°. Bottom stony; only a small sample of brown argillaceous sand. A great many pebbles of calcareous spar.

Station 46. — Lat. 63° 51′ N., long. 12° 5′ W.; d. 257 fms. (470 m.); b.-t. 3.9°. Pebbles and a grey clay.

Station 47. — Lat. 64° 13.5′ N., long. 11° 14′ W.; d. 190 fms. (347 m.); b.-t. 6.0°. Bottom stony.

Station 48. — Lat. 64° 36′ N., long. 10° 22′ W.; d. 299 fms. (547 m.); b.-t. — 0.3°. A dark-grey, porous clay containing a few pebbles of quartz and granite (the largest weighing 1 gr.) and a few calcareous shells.

Station 49. — Lat. 65° 0′ N., long. 9° 25′ W.; d. 437 fms. (799 m.); b.-t. — 0.8°. A sabulous clay.

Station 50. — Lat. 65° 26′ N., long. 8° 24′ W.; d. 571 fms. (1044 m.); b.-t. — 0.9°. A dark, bluish-grey clay. No pebbles.

Station 51. — Lat. 65° 53′ N., long. 7° 18′ W.; d. 1163 fms. (2127 m.); b.-t. — 1.1°. Biloculina clay. No pebbles.

Station 52. — Lat. 65° 47′ N., long. 3° 7′ W.; d. 1861 fms. (3403 m.); b.-t. — 1.2°. Biloculina clay. No pebbles.

Station 53. — Lat. 65° 13′ N., long. 0° 33′ E.; d. 1539 fms. (2814 m.); b.-t. — 1.3°. Biloculina clay; to every □cm. of the dried sample 2 or 3 *Biloculinæ*. No pebbles.

Station 54. — Lat. 64° 47′ N., long. 4° 24′ E.; d. 601 fms. (1099 m.); b.-t. — 1.2°. Biloculina clay, containing a great many *Globigerinæ*. No pebbles.

Station 55. — Lat. 64° 38′ N., long. 10° 22′ E.; d. 93 fms. (170 m.); b.-t. 7.2°. Bottom stony.

Station 56. — Lat. 64° 39′ N., long. 10° 11′ E.; d. 178 fms. (326 m.); b.-t. 7.2°. A grey, porous, finely granulated, sandy clay containing but few inorganic animal remains.

Station 57. — Lat. 64° 39′ N., long. 9° 59′ E.; d. 161 fms. (284 m.); b.-t. 7.0°. A finely granulous, bluish-grey, compact clay containing numerous pebbles of crystalline schists, the largest weighing 1.5 gr. No calcareous shells.

Station 58. — Lat. 64° 39′ N., long. 9° 49′ E.; d.

(404 M.). 6.9°. Blaagraat, fint, fast Ler. Mange fine Glimmerblade, men forresten ingen Stene. Yderst faa uorganiske Dyrelevninger.

221 fms. (404 m.); b.-t. 6.9°. A fine, bluish-grey, compact clay containing numerous delicate laminæ of mica, but no pebbles, and very few inorganic animal remains.

Station 59. N. B. 64° 39′, Ø. L. 9° 38′. 167 Fvn. (305 M.). 6.9°. Graat, grovkornigt Ler. Nogle smaa Stene. Faa uorganiske Dyrelevninger.

Station 59. — Lat. 64° 39′ N., long. 9° 38′ E.; d. 167 fms. (305 m.); b.-t. 6.9°. A grey, coarsely granulated clay containing pebbles and a few inorganic animal remains.

Station 60. N. B. 64° 40′, Ø. L. 9° 30′. 118 Fvn. (216 M.). 7.0°. En liden Prøve af graat, uensartet, sandholdigt Ler. Mange Stene (veiende indtil 0.3 Gr.), bestaaende af rød Granit og krystallinske Skifere. Yderst faa Kalkskaller.

Station 60. — Lat. 64° 40′ N., long. 9° 30′ E.; d. 118 fms. (216 m.); b.-t. 7.0°. A small sample of grey, sabulous clay containing numerous pebbles (the largest weighing 0.3 gr.) of red granite and crystalline schists, and a very few calcareous shells.

Station 61. N. B. 64° 40′, Ø. L. 9° 19′. 118 Fvn. (216 M.). 7.0°. En liden Prøve af graat, fint, ensartet Ler. En liden Sten: glindsende Lerskifer (veiende 0.1 Gr.).

Station 61. — Lat. 64° 40′ N., long. 9° 19′ E.; d. 118 fms. (216 m.); b.-t. 7.0°. A little fine, grey, homogeneous clay containing a small pebble of glittering argillaceous state (weight 0.1 gr.).

Station 62. N. B. 64° 41′, Ø. L. 9° 10′. 108 Fvn. (198 M.). 7.0°. Blaaliggraat, fint Ler. Nogle meget smaa Stene.

Station 62. — Lat. 64° 41′ N., long. 9° 10′ E.; d. 108 fms. (198 m.); b.-t. 7.0°. A bluish-grey clay containing a few very small pebbles.

Station 63. N. B. 64° 41′, Ø. L. 9° 0′. 93 Fvn. (170 M.). 7.0°. Stenbund.

Station 63. — Lat. 64° 41′ N., long. 9° 0′ E.; d. 93 fms. (170 m.); b.-t. 7.0°. Bottom stony.

Station 64. N. B. 64° 42′, Ø. L. 8° 50′. 58 Fvn. (106 M.). 7.7°. Stenbund.

Station 64. — Lat. 64° 42′ N., long. 8° 50′ E.; d. 58 fms. (106 m.); b.-t. 7.7°. Bottom stony.

Station 65. N. B. 64° 42′, Ø. L. 8° 39′. 62 Fvn. (113 M.). 7.4°. Stenbund.

Station 65. — Lat. 64° 42′ N., long. 8° 39′ E.; d. 62 fms. (113 m.); b.-t. 7.4°. Bottom stony.

Station 66. N. B. 64° 43′, Ø. L. 8° 30′. 88 Fvn. (161 M.). 7.1°. En liden Prøve af graat, sandholdigt, fast Ler. Ingen Stene.

Station 66. — Lat. 64° 43′ N., long. 8° 30′ E.; d. 88 fms. (161 m.); b.-t. 7.1°. A small sample of grey, compact, sabulous clay. No pebbles.

Station 67. N. B. 64° 44′, Ø. L. 8° 19′. 119 Fvn. (218 M.). 6.9°. Blaagraat Ler. Mange smaa Stene (veiende indtil 0.3 Gr.), bestaaende af Kvarts, Kvartsit. Yderst faa Kalkskaller.

Station 67. — Lat. 64° 44′ N., long. 8° 19′ E.; d. 119 fms. (218 m.); b.-t. 6.9°. A bluish-grey clay containing many small pebbles (the largest weighing 3 gr.) of quartz, quartzite, and a very few calcareous shells.

Station 68. N. B. 64° 44′, Ø. L. 8° 9′. 132 Fvn. (241 M.). 6.9°. Graat, fint, ensartet Ler. Ingen Stene.

Station 68. — Lat. 64° 44′ N., long. 8° 9′ E.; d. 132 fms. (241 m.); b.-t. 6.9°. A fine, grey, homogeneous clay. No pebbles.

Station 69. N. B. 64° 45′, Ø. L. 8° 2′. 128 Fvn. (234 M.). 7.0°. Graat, meget sandholdigt Ler.

Station 69. — Lat. 64° 48′ N., long. 8° 2′ E.; d. 128 fms. (234 m.); b.-t. 7.0°. A grey, exceedingly sabulous clay.

Station 79.[1] N. B. 64° 48′, Ø. L. 6° 36′. 155 Fvn.

Station 79.[1] — Lat. 64° 48′ N., long. 6° 36′ E.; d.

[1] Fra de imellem 69 og 79 liggende Stationer er ingen Prøver medbragte hjem. Ifølge Loddejournalen fandtes paa alle disse Stationer et graat, sandholdigt Ler. Da disse Stationer følger meget tæt paa hinanden, har jeg fundet det unødvendigt at medtage dem i Fort.

[1] From the 8 Stations between 69 and 79 no samples were collected. According to the sounding-journal, a grey, sabulous clay occurred at each; and being all so near together, I have not included them in the List.

(283 M.). 6.9°. Graat, sandholdigt, fast Ler med noget af en løsere Slags. Mange Stene (veiende indtil 0.3 Gr.), bestaaende af Kvarts, Glimmer, forvitrende Horblende (?), Marmor, krystallinske Skifere. Mange Skaller af Slægten *Urigerina*.

155 fms. (283 m.); b.-t. 6.9°. A grey, sabulous clay, part compact and part comparatively porous, containing many small pebbles (the largest weighing 0.3 gr) of quartz, mica, disintegrated hornblende (?), marble, and crystalline schists, together with numbers of shells of the genus *Urigerina*.

Station 80. N. B. 64° 48', Ø. L. 6° 26'. 144 Fvn. (263 M.). 6.8°. Graat, fint Ler.

Station 80. — Lat. 64° 48' N., long. 6° 26' E.; d. 144 fms. (263 m.); b-t. 6.8°. A finely granulous, grey clay.

Station 81. N. B. 64° 49', Ø. L. 6° 17'. 155 Fvn. (283 M.). 6.9°. Graat, fint Ler Nogle Stene (veiende indtil 1 Gr.), bestaaende af Granit og krystallinske Skifere.

Station 81. — Lat. 64° 49' N., long. 6° 17' E.; d. 155 fms. (283 m.); b.-t. 6.9°. A finely granulous, grey clay containing a few very small pebbles (the largest weighing 1 gr), of granite and crystalline schists.

Station 84. N. B. 64° 49', Ø. L. 5° 49'. 221 Fvn. (404 M.). 6.5°. Graat, fint Ler.

Station 84. — Lat. 64° 49' N., long. 5° 49' E.; d. 221 fms. (404 m.); b.-t. 6.5°. A finely granulous, grey clay.

Station 85. N. B. 64° 50', Ø. L. 5° 39'. 303 Fvn. (554 m.). 3.9°. Brunt Sandler.

Station 85. — Lat. 64° 50' N., long. 5° 39' E.; d. 303 fms. (554 m.); b.-t. 3.9°. A brown, sabulous clay.

Station 86. N. B. 64° 50', Ø. L. 5° 30'. 381 Fvn. (697 M.). — 1.0°. Graat Ler.

Station 86. — Lat. 64° 50' N., long. 5° 30' E.; d. 381 fms. (697 m.); b.-t. — 1.0°. A grey clay.

Station 87. N. B. 64° 2', Ø. L. 5° 35'. 498 Fvn. (911 M.). — 1.1°. Graat Ler.

Station 87. — Lat. 64° 2' N., long. 5° 35' E.; d. 498 fms. (911 m.); b.-t. — 1.1°. A grey clay.

Station 88. N. B. 64° 1', Ø. L. 5° 53'. 355 Fvn. (649 M.). 2.7°. Graat Ler.

Station 88. — Lat. 64° 1' N., long. 5° 53' E.; d. 355 fms. (649 m.); b.-t. 2.7°. A grey clay.

Station 89. N. B. 64° 1', Ø. L. 6° 8'. 190 Fvn. (347 M.). 6.7°. Stenbund.

Station 89. — Lat. 64° 1' N., long. 6° 8' E.; d. 190 fms. (347 m.); b.-t. 6.7°. Bottom stony.

Station 90. N. B. 64° 1', Ø. L. 6° 21'. 205 Fvn. (375 M.). 6.6°. Graat, sandholdigt Ler.

Station 90. — Lat. 64° 1' N., long. 6° 21' E.; d. 205 fms. (375 m.); b.-t. 6.6°. A grey, sabulous clay.

Station 91. N. B. 64° 0', Ø. L. 6° 32'. 190 Fvn. (347 M.). 7.2°. Graat, fint Ler.

Station 91. — Lat. 64° 0' N., long. 6° 32' E.; d. 190 fms. (347 m.); b.-t. 7.2°. A finely granulous, grey clay.

Station 92. N. B. 64° 0', Ø. L. 6° 42'. 178 Fvn. (326 M.). 7.2°. Graat, sandholdigt Ler. Nogle faa Stene. Mange fine Glimmerblade.

Station 92. — Lat. 64° 0' N., long. 6° 42' E.; d. 178 fms. (326 m.); b.-t. 7.2°. A grey, sabulous clay containing a few pebbles and many delicate laminæ of mica.

Station 93. N. B. 62° 41', Ø. L. 7° 8'. 158 Fvn. (289 M.). 6.4°. Romsdalsfjord. Løst, graat Ler.

Station 93 (the Romsdal Fjord). — Lat. 62° 41' N., long. 7° 8' E.; d. 158 fms. (289 m.); b.-t. 6.4°. A grey, porous clay.

Bundprøver fra 1877.

Station 94. N. B. 59° 8′. Ø. L. 4° 38′. 145 Fvn. (265 M.). 5.0°. En liden Prøve af graat, grovkornigt Ler.

Station 95. N. B. 60° 42′. Ø. L. 4° 14′. 175 Fvn. (320 M.). 5.8°. Brungraat Ler med mange Brudstykker af Kalkskaller, Koraller og andre Dyrelevninger. Nogle smaa Kvartskorn.

Station 96. N. B. 66° 8′. Ø. L. 3° 0′. 805 Fvn. (1472 M.). — 1.1°. Bundprøven bestod af to Lag. Øverst et brunt Ler, hvori der ikke kunde opdages Biloculiner og kun faa Globigeriner, men temmelig mange af Slægten *Lituola*. Man kan være i Tvivl om, hvorvidt dette Ler skal betragtes som Overgangsler eller Biloculinler. Jeg har imidlertid fundet det rettest at henregne det til det sidste (som dannende Begyndelsen til Biloculinleret). Det underliggende Lag af Bundprøven bestod af et graat, fint Ler. I Bundprøven ingen Stene. I Skraben fandtes 3 mindre Stene (den største 3 × 3 × 3 Cm.), bestaaende af blaa Kvarts, Sandsten, krystallinske Skifere.

Station 97. N. B. 66° 2′. Ø. L. 4° 21′. 683 Fvn. (1249 M.). — 1.1°. To Lag i Bundprøven. Det øverste bestod af brunt Overgangsler, det underste af graat, fint Ler. Ingen Stene.

Station 98. N. B. 65° 56′. Ø. L. 5° 21′. 388 Fvn. (710 M.). — 1.0°. To Lag i Bundprøven. Det øverste brunt Overgangsler, det underste graat Ler. Ingen Stene.

Station 99. N. B. 65° 51′. Ø. L. 6° 25′. 213 Fvn. (390 M.). 6.1°. Graabrunt, finkornigt, sandholdigt Ler. En liden Sten: Kvarts.

Station 100. N. B. 65° 43′. Ø. L. 7° 29′. 194 Fvn. (355 M.). 6.0°. Blanding af brunt Sandler og graat Ler. Mange Stene. Et lidet Stykke af en *Belemnit*.

Station 101. N. B. 65° 36′. Ø. L. 8° 32′. 223 Fvn. (408 M.). 6.0°. Graat, grovkornigt Sandler. Mange Stene (veiende indtil 1.5 Gr., bestaaende af Kvarts, krystallinske Skifere, Hornblende (?). I Skraben fandtes 6 smaa Stene: *Flint, Kridt*, Sandsten og krystallinske Skifere.

Station 102. N. B. 65° 32′. Ø. L. 9° 10′. 211 Fvn. (386 M.). 6.2°. Lysgraat Ler, tilblandet noget brunt Sandler. Ingen Stene.

Station 103. N. B. 65° 30′. Ø. L. 9° 37′. 193

Samples of the Bottom (1877).

Station 94. — Lat. 59° 8′ N., long. 4° 38′ E.; d. 145 fms. (265 m.); b.-t. 5.0°. A small sample of grey, coarsely granulated clay.

Station 95. — Lat. 60° 42′ N., long. 4° 14′ E.; d. 175 fms. (320 m.); b.-t. 5.8°. A brownish-grey clay containing many fragments of calcareous shells, coral, and other animal remains; also a few quartz pebbles.

Station 96. — Lat. 66° 8′ N., long. 3° 0′ E.; d. 805 fms. (1472 m.); b.-t. — 1.1°. The sample consisted of two layers. In the upper — a brown clay — no *Biloculinæ* could be detected, and but very few *Globigerinæ*; it contained however a good many shells of the genus *Lituola*. It is difficult to decide whether this clay be a transition or a true Biloculina clay. Meanwhile, I have regarded it as the latter (as constituting the first bottom-layer of Biloculina clay). The under layer was a finely granulous, grey clay. No pebbles in this sample. The dredge brought up 3 pebbles (the largest 3 × 3 × 3 cm), consisting of blue quartz, sandstone, and crystalline schists.

Station 97. — Lat. 66° 2′ N., long. 4° 21′ E.; d. 683 fms. (1249 m.); b.-t. 1.1°. Two layers in this sample; the upper consisting of a brown transition clay, the under of a finely granulous, grey clay. No pebbles.

Station 98. — Lat. 65° 56′ N., long. 5° 21′ E.; d. 388 fms. (710 m.); b.-t. — 1.0°. Two layers; the upper a brown transition clay, the under a grey clay. No pebbles.

Station 99. — Lat. 65° 51′ N., long. 6° 25′ E.; d. 213 fms. (390 m.); b.-t. 6.1°. A greyish-brown, finely granulous, sandy clay containing a quartz pebble.

Station 100. — Lat. 65° 43′ N., long. 7° 29′ E.; d. 194 fms. (355 m.); b.-t. 6.0°. A mixture of brown sabulous clay and grey clay containing many pebbles and a small fragment of a *belemnite*.

Station 101. — Lat. 65° 36′ N., long. 8° 32′ E.; d. 223 fms. (408 m.); b.-t. 6.0°. A grey, coarsely granulated, sabulous clay containing a good many pebbles (the largest weighing 1.5 gr) of quartz, crystalline schists, hornblende (?). The dredge brought up 6 small stones, consisting of *flint, chalk*, sandstone, and crystalline schists.

Station 102. — Lat. 65° 32′ N., long. 9° 10′ E.; d. 211 fms. (386 m.); b.-t. 6.2°. A light-grey clay, slightly mixed with a brown, sabulous clay. No pebbles.

Station 103. — Lat. 65° 30′ N., long. 9° 37′ E.; d.

Fvn. (353 M.). 6.4°. Graat, grovkornigt Ler. Mange Stene (veiende indtil 3 Gr.), bestaaende af krystallinske Skifere.

Station 104. N. B. 65° 28′. Ø. L. 9° 56′. 162 Fvn. (296 M.). 6.5°. Graat, grovkornigt, sandholdigt Ler. Mange Stene (veiende indtil 0.5 Gr.), bestaaende af Kvarts, krystallinske Skifere, forvitret Hornblende (?).

Station 105. N. B. 65° 26′. Ø. L. 10° 13′. 145 Fvn. (265 M.). 6.6°. Graat, sandholdigt Ler. Faa Kalkskaller.

Station 106. N. B. 65° 24′. Ø. L. 10° 33′. 177 Fvn. (324 M.). 6.5°. Graat Ler, indsprængt med en Mængde Glimmerblade.

Station 107. N. B. 65° 21′. Ø. L. 10° 44′. 172 Fvn. (315 M.). 6.2°. Ensartet, graat Ler. Mange Stene (veiende indtil 0.6 Gr.), bestaaende af fin, hvid Kvarts.

Station 108. N. B. 66° 6′. Ø. L. 11° 1′. 127 Fvn. (232 M.). 6.0°. Graat, sandholdigt Ler.

Station 109. N. B. 66° 10′. Ø. L. 10° 41′. 180 Fvn. (329 M.). 6.2°. Graat, sandholdigt Ler.

Station 110. N. B. 66° 12′. Ø. L. 10° 30′. 159 Fvn. (291 M.). 6.2°. Graat, ensartet Ler. Ingen Stene.

Station 111. N. B. 66° 15′. Ø. L. 10° 21′. 157 Fvn. (287 M.). 6.2°. Brunliggraat Ler med lidt Sand i det øverste Lag. Ingen Stene. Faa Kalkskaller.

Station 112. N. B. 66° 16′. Ø. L. 10° 10′. 138 Fvn. (252 M.). 6.3°. Grønliggraat Ler (ligner Rhabdammina-Ler). Et Stykke Kvarts af Størrelse og Form som en Nød; forresten ingen Stene.

Station 113. N. B. 66° 18′. Ø. L. 10° 0′. 123 Fvn. (225 M.). 6.2°. Blanding af brunt Sandler med talrige uorganiske Dyrelevninger og graat Ler. Nogle smaa Kvartsstykker; forresten ingen Stene.

Station 114. N. B. 66° 18′. Ø. L. 9° 51′. 120 Fvn. (219 M.). 6.2°. Graat, grovkornigt Ler. Mange Stene (veiende indtil 6 Gr.), bestaaende af Kvarts, Feldspath med Hornblende, Granit. I Skraben fandtes mange Kvartsstykker. Faa Kalkskaller.

193 fms. (353 m.); b.-t. 6.4°. A grey, coarse clay containing a good many pebbles (the largest weighing 3 gr) of crystalline schists.

Station 104. — Lat. 65° 28′ N., long. 9° 56′ E.; d. 162 fms. (296 m.); b.-t. 6.5°. A grey, coarse sandy clay containing a good many pebbles (the largest weighing 0.5 gr) of quartz, crystalline schists, disintegrated hornblende (?).

Station 105. — Lat. 65° 26′ N., long. 10° 13′ E.; d. 145 fms. (265 m.); b.-t. 6.6°. A grey, sabulous clay containing a few calcareous shells.

Station 106. — Lat. 65° 24′ N., long. 10° 33′ E.; d. 177 fms. (324 m.); b.-t. 6.5°. A grey clay containing a great many laminæ of mica.

Station 107. — Lat. 65° 21′ N., long. 10° 44′ E.; d. 172 fms. (315 m.); b.-t. 6.2°. A grey, homogeneous clay containing a good many pebbles (the largest weighing 0.6 gr) of white quartz.

Station 108. — Lat. 66° 6′ N., long. 11° 1′ E.; d. 127 fms. (232 m.); b.-t. 6.0°. A grey, sabulous clay.

Station 109. — Lat. 66° 10′ N., long. 10° 41′ E.; d. 180 fms. (329 m.); b.-t. 6.2°. A grey, sabulous clay.

Station 110. — Lat. 66° 12′ N., long. 10° 30′ E.; d. 159 fms. (291 m.); b.-t. 6.2°. A grey, homogeneous clay. No pebbles.

Station 111. — Lat. 66° 15′ N., long. 10° 21′ E.; d. 157 fms. (287 m.); b.-t. 6.2°. A brownish-grey clay, along with a little sand in the upper layer, containing a few calcareous shells. No pebbles.

Station 112. — Lat. 66° 16′ N., long. 10° 10′ E.; d. 138 fms. (252 m.); b.-t. 6.3°. A greenish-grey clay (very similar in appearance to Rhabdammina clay) containing a small fragment of quartz, of the size and shape of a hazel-nut. No other pebbles.

Station 113. — Lat. 66° 18′ N., long. 10° 0′ E.; d. 123 fms. (225 m.); b.-t. 6.2°. A mixture of brown, sabulous clay, with numerous inorganic animal remains, and grey clay containing a few small fragments of quartz, but no other pebbles.

Station 114. — Lat. 66° 18′ N., long. 9° 51′ E.; d. 120 fms. (219 m.); b.-t. 6.2°. A grey, coarse clay containing a good many pebbles (the largest weighing 6 gr) of quartz, feldspat, hornblende, granite, and a few calcareous shells. Numerous fragments of quartz came up in the dredge.

Station 115. N. B. 66° 20′. Ø. L. 9° 41′. 132 Fvn. (241 M.). 6.2°. Graat Ler med talrige Glimmerblade. Mange Stene (veiende indtil 1 Gr.), bestaaende af Kvarts, Glimmerskifer o. fl.

Station 116. N. B. 66° 21′, Ø. L. 9° 30′. 121 Fvn. (221 M.). 6.2°. Grønliggraat, grovkornigt Ler. Mange smaa Stene.

Station 117. N. B. 66° 23′, Ø. L. 9° 20′. 141 Fvn. (258 M.). 6.2°. Brunliggraat, ensartet Ler (lig Stat. 111). Ingen Stene.

Station 118. N. B. 66° 26′. Ø. L. 8° 59′. 141 Fvn. (258 M.). 6.2°. Graat, grovkornigt Ler. Mange Stene (veiende indtil 1 Gr.), bestaaende af Kvarts, Glimmerskifer, lys Granit.

Station 119. N. B. 66° 28′, Ø. L. 8° 40′. 168 Fvn. (307 M.). 6.2°. Graat, ensartet Ler. Nogle smaa Stene (veiende indtil 0.1 Gr.), bestaaende af Kvarts og krystallinske Skifere.

Station 120. N. B. 66° 30′, Ø. L. 8° 20′. 190 Fvn. (347 M.). 6.2°. Brunliggraat Ler. Nogle Stene (veiende indtil 3 Gr.), bestaaende af Kvarts, Gneis, Granit.

Station 121. N. B. 66° 33′, Ø. L. 7° 59′. 192 Fvn. (351 M.). 4.8°. Graat Ler med mange Kalkskaller. Ingen Stene.

Station 122. N. B. 66° 36′, Ø. L. 7° 40′. 201 Fvn. (368 M.). 4.9°. Graat, ensartet Ler. Mange Stene (veiende indtil 4 Gr.).

Station 123. N. B. 66° 39′, Ø. L. 7° 19′. 246 Fvn. (450 M.). 5.6°. En liden Prøve af graat, uensartet, grovkornigt, klumpet Ler med mange Stene (veiende indtil 1.5 Gr.) bestaaende af: Kvarts, Granit og krystallinske Skifere.

Station 124. N. B. 66° 41′, Ø. L. 6° 59′. 350 Fvn. (640 M.). —0.9°. Bundprøven bestod af noget graat Ler med en Mængde Stene, væsentlig bestaaende af *Flint* og krystallinske Skifere. Skrabens Indhold bestod overveiende af Stene (den største 8 × 14 × 8 Cm.), der blev bestemt som: Finkornig rød Granit, grovkornig Ganggranit, hvid Granit med Ortit, Gneisgranit (med Hornblende, Plagioklas, Ortoklas), Hornblendeskifer, mørke krystallinske Skifere (med Kvarts, Glimmer, Granat), Glimmerskifer med Kis, Sandsten, grønlig Kvarts og grøn Feldspath. Disse Bergarter forekom i nævestore Stykker. Desuden fandtes en Mængde *Flint-* og *Kridstykker*, de sidste ialmindelighed runde (indtil 4 Cm. i Diameter).

Station 115. — Lat. 66° 20′ N., long. 9° 41′ E.; d. 132 fms. (241 m.); b.-t. 6.2°. A grey clay containing numerous laminæ of mica and many pebbles (the largest weighing 1 gr) of quartz, mica, schist, &c.

Station 116. — Lat. 66° 11′ N., long. 9° 30′ E.; d. 121 fms. (221 m.); b.-t. 6.2°. A greenish-grey, coarse clay containing many pebbles.

Station 117. — Lat. 66° 23′ N., long. 9° 20′ E.; d. 141 fms. (258 m.); b.-t. 6.2°. A brownish-grey, homogeneous clay resembling that brought up at Stat. 111. No pebbles.

Station 118. — Lat. 66° 26′ N., long. 8° 59′ E.; d. 141 fms. (258 m.); b.-t. 6.2°. A grey, coarse clay containing numerous pebbles (the largest weighing 1 gr) of quartz, mica, schist, granite.

Station 119. — Lat. 66° 28′ N., long. 8° 40′ E.; d. 168 fms. (307 m.); b.-t. 6.2°. A grey, homogeneous clay containing a few pebbles (the largest weighing 1 gr) of quartz and crystalline schists.

Station 120. — Lat. 66° 30′ N., long. 8° 20′ E.; d. 190 fms. (347 m.); b.-t. 6.2°. A brownish-grey clay containing a few pebbles (the largest weighing 3 gr) of quartz, gneiss, granite.

Station 121. — Lat. 66° 35′ N., long. 7° 59′ E.; d. 192 fms. (351 m.); b.-t. 4.8°. A grey clay containing many calcareous shells. No pebbles.

Station 122. — Lat. 66° 36′ N., long. 7° 40′ E.; d. 201 fms. (368 m.); b.-t. 4.9°. A grey homogeneous clay containing many pebbles (the largest weighing 4 gr).

Station 123. — Lat. 66° 39′ N., long. 7° 19′ E.; d. 246 fms. (450 m.); b.-t. 5.6°. A small sample of grey, coarse, lumpy clay containing many pebbles (the largest weighing 1.5 gr) of quartz, granite, and crystalline schists.

Station 124. — Lat. 66° 41′ N., long. 6° 59′ E.; d. 350 fms. (640 m.); b.-t. —0.9°. A grey clay containing a great many pebbles, chiefly of *flint* and crystalline schists. The dredge brought up a freight consisting almost exclusively of stones and pebbles (the largest 8 × 14 × 8 cm). determined as follows: Finely granulated red granite, coarsely granulous vein-granite, white granite and ortite, gneiss-granite (containing hornblende, plagioklas, ortoklas), hornblende slate, dark crystalline schists (containing quartz, mica, granite), mica slate with pyrites, greenish quartz, and green feldspat. These fragments were as big as a man's fist. Moreover, the dredge-bag contained a great many pebbles of *flint* and *chalk*, most of the latter round, and the largest measuring 4 cm in diameter.

Station 125. N. B. 67° 52', Ø. L. 5° 12'. 700 Fvn. (1280 M.). — 1.1°. Brunt Overgangsler. Nogle Stene.

Station 126. N. B. 67° 49', Ø. L. 5° 33'. 730 Fvn. (1335 M.). — 1.1°. Brunt Overgangsler uden Biloculiner og Globigeriner.

Station 127. N. B. 67° 47', Ø. L. 5° 54'. 715 Fvn. (1308 M.). — 1.1°. Brunt Overgangsler. Ingen Biloculiner eller Globigeriner. Ingen Stene.

Station 128. N. B. 67° 43', Ø. L. 6° 21'. 688 Fvn. (1258 M.). — 1.2°. Biloculinler, noget uensartet i Farven. Ingen Stene.

Station 129. N. B. 67° 40', Ø. L. 6° 42'. 709 Fvn. (1296 M.). — 1.2°. Blanding af Biloculinler og mere graaligt Ler. I Leret opdagedes blot Globigeriner, ingen Biloculiner[1]. Nogle Stene (veiende indtil 0.2 Gr.), bestaaende af Kvarts, Kvartsit, Glimmerskifer, Sandsten (?).

Station 130. N. B. 67° 38', Ø. L. 7° 3'. 689 Fvn. (1260 M.). — 1.1°. Bundprøven mangler; i Loddejournalen er blot noteret: Ler.

Station 131. N. B. 67° 35', Ø. L. 7° 26'. 795 Fvn. (1454 M.). — 1.2°. Blanding af brunt, lysgraat og morkgraat Ler. Ingen Biloculiner eller Globigeriner. Ingen Stene.

Station 132. N. B. 67° 33', Ø. L. 7° 48'. 954 Fvn. (1745 M.). — 1.2°. To Lag i Bundprøven. Øverst brunt Overgangsler, underst graat Ler.

Station 133. N. B. 67° 30', Ø. L. 8° 10'. 890 Fvn. (1628 M.). — 1.3°. Brunt Overgangsler med noget morkbrunt Ler. En liden Sten: Kvarts.

Station 134. N. B. 67° 29', Ø. L. 8° 20'. 878 Fvn. (1606 M.). — 1.2°. Uensartet, graat, grovkornigt Ler. Mange Stene (veiende indtil 0.5 Gr.), bestaaende af Kvarts, Feldspath (?), krystallinske Skifere, Granit.

Station 135. N. B. 67° 27', Ø. L. 8° 31'. 860 Fvn. (1573 M.). — 1.2°. Brunt Overgangsler. Nogle Globigeriner kunde opdages. Ingen Stene.

Station 136. N. B. 67° 25', Ø. L. 8° 47'. 610 Fvn.

[1] Sml. Stat. 96.

Station 125. — Lat. 67° 52' N., long. 5° 12' E.; d. 700 fms. (1280 m.); b.-t. — 1.1°. A brown transition clay containing a few pebbles.

Station 126. — Lat. 67° 49' N., long. 5° 33' E.; d. 730 fms. (1335 m.); b.-t. — 1.1°. A brown transition clay without either *Biloculinæ* or *Globigerinæ*.

Station 127. — Lat. 67° 47' N., long. 5° 54' E.; d. 715 fms. (1308 m.); b.-t. — 1.1°. A brown transition clay without either *Biloculinæ* or *Globigerinæ*. No pebbles.

Station 128. — Lat. 67° 43' N., long. 6° 21' E.; d. 688 fms. (1258 m.); b.-t. — 1.2°. Biloculina clay, differing slightly in colour. No pebbles.

Station 129. — Lat. 67° 40' N., long. 6° 42' E.; d. 709 fms. (1296 m.); b.-t. — 1.2°. A mixture of Biloculina clay and a clay of a greyer tint containing *Globigerinæ* (no *Biloculinæ* could be detected[1]) and a few pebbles (the largest weighing 0.2 gr.) of quartz, quartzite, mica schist, sandstone (?).

Station 130. — Lat. 67° 38' N., long. 7° 3' E.; d. 689 fms. (1260 m.); b.-t. — 1.1°. No sample from this Station. The entry in the sounding-journal is simply "clay."

Station 131. — Lat. 67° 35' N., long. 7° 26' E.; d. 795 fms. (1454 m.); b.-t. — 1.2°. A mixture of brown, light-grey, and dark-grey clay. No *Biloculinæ* or *Globigerinæ*; and no pebbles.

Station 132. — Lat. 67° 33' N., long. 7° 48' E.; d. 954 fms. (1745 m.); b.-t. — 1.2°. Two layers in this sample: the upper a brown transition, the under a grey clay.

Station 133. — Lat. 67° 30' N., long. 8° 10' E.; d. 890 fms. (1628 m.); b.-t. — 1.3°. A brown transition clay, along with a little dark-brown clay, containing a small fragment of quartz.

Station 134. — Lat. 67° 29' N., long. 8° 20' E.; d. 878 fms. (1606 m.); b.-t. — 1.2°. A grey, coarse clay containing many pebbles (the largest weighing 0.5 gr.) of quartz, feldspat (?), crystalline schists, granite.

Station 135. — Lat. 67° 27' N., long. 8° 31' E.; d. 860 fms. (1573 m.); b.-t. — 1.2°. A brown transition clay in which a few *Globigerinæ* could be detected. No pebbles.

Station 136. — Lat. 67° 25' N., long. 8° 47' E.;

[1] See Stat. 96.

(1116 M.). — 1.1°. Brunt Overgangsler, meget uensartet i Farve. Mange Stene (veiende indtil 0.2 Gr.), bestaaende af Kvarts, Granit o. fl.

d. 610 fms. (1116 m.): b.-t. — 1.1°. A brown transition clay varying considerably in colour. It contained many pebbles (the largest weighing 0.2 gr) of quartz, granite, &c.

Station 137. N. B. 67° 24′. Ø. L. 8° 58′. 452 Fvn. (827 M.). — 1.0°. Blaaliggraat Ler. Mange og forholdsvis store Stene (veiende indtil 8 Gr.), bestaaende af Kvarts, Asbest, Glimmerskifer, Gneis med Granit. I Skraben fandtes ligeledes mange Stene, nogle med tydelige Skurstriber og glattede Overflader, store som Barnehoveder. Graa Gneis, hvid stribet Granit, rod stribet Granit, graa tæt Kvartsporfyr, finkornig Glimmerskifer, rod Kvarts.

Station 137. — Lat. 67° 24′ N., long. 8° 58′ E.; d. 452 fms. (827 m.); b.-t. — 1.0°. A bluish-grey clay containing many and comparatively large pebbles (weighing up to 8 gr) of quartz, asbestos, mica schist, gneiss with granite. The dredge brought up at this Station numerous pebbles and stones, consisting of grey gneiss, white lamellar granite, red lamellar granite, grey, compact quartz-porphyry, finely granulated mica schist, and red quartz. Some of these stones, as big as a child's head, had the surface polished with distinctly perceptible striæ.

Station 138. N. B. 67° 18′. Ø. L. 9° 9′. 184 Fvn. (336 M.). 6.0°. Grovt Sand og Sten.

Station 138. — Lat. 67° 18′ N., long. 9° 9′ E.; d. 184 fms. (336 m.); b.-t. 6.0°. Coarse sand and stones

Station 139. N. B. 67° 14′. Ø. L. 9° 25′. 175 Fvn. (320 M.). 6.2°. Graa, grovkornigt Ler. Mange og forholdsvis store Stene (veiende indtil 1.5 Gr.), bestaaende af krystallinske Skifere, Feldspath o. fl.

Station 139. — Lat. 67° 14′ N., long. 9° 25′ E.; d. 175 fms. (320 m.): b.-t. 6.2°. A grey, coarse clay containing many pebbles (the largest weighing 1.5 gr) of crystalline schists, feldspat, &c.

Station 140. N. B. 67° 10′. Ø. L. 9° 42′. 197 Fvn. (360 M.). 6.2°. Graat Ler med mange Stene.

Station 140. — Lat. 67° 11′ N., long. 9° 42′ E.; d. 197 fms. (360 m.); b.-t. 6.2°. A grey clay containing many pebbles.

Station 141. N. B. 67° 6′. Ø. L. 9° 59′. 192 Fvn. (351 M.). 6.2°. Graat, grovkornigt Sandler. Mange smaa Stene (veiende indtil 0.5 Gr.), bestaaende af Kvarts, hvid Granit, krystallinske Skifere.

Station 141. — Lat. 67° 6′ N., long. 9° 59′ E.; d. 192 fms. (351 m.): b.-t. 6.2°. A grey, coarse, sandy clay containing many pebbles (weighing up to 0.5 gr) of quartz, white granite, crystalline schists.

Station 142. N. B. 67° 2′. Ø. L. 10° 17′. 178 Fvn. (326 M.). 6.2°. Grønliggraat Ler, gjennemvævet af Kiselspikuler af Svampe. Mange Stene (veiende indtil 2 Gr.), bestaaende af rod Granit og krystallinske Skifere.

Station 142. — Lat. 67° 2′ N., long. 10° 17′ E.; d. 178 fms. (326 m.); b.-t. 6.2°. A greenish-grey clay interwoven with the siliceous spicules of sponges, and containing many pebbles (weighing up to 2 gr) of red granite and crystalline schists.

Station 143. N. B. 66° 58′. Ø. L. 10° 33′. 189 Fvn. (346 M.). 6.2°. Graat, klumpet Ler med mange Stene (veiende indtil 3 Gr.), bestaaende af Kvarts og krystallinske Skifere.

Station 143. — Lat. 66° 58′ N., long. 10° 33′ E.; d. 189 fms. (346 m.); b.-t. 6.2°. A grey, lumpy clay containing many pebbles (the largest weighing 3 gr) of quartz and crystalline schists.

Station 144. N. B. 66° 53′. Ø. L. 10° 50′. 183 Fvn. (335 M.). 6.2°. Graat, grovkornigt, meget sandholdigt, usammenhængende Ler. Mange smaa Stene (veiende indtil 0.1 Gr.), bestaaende af Kvarts og krystallinske Skifere. Mange Kalkskaller (især Slægten *Discorbina*).

Station 144. — Lat. 66° 53′ N., long. 10° 50′ E.; d. 183 fms. (335 m.); b.-t. 6.2°. A grey, coarse, exceedingly sabulous, friable clay containing many pebbles (the largest weighing 0.1 gr) of quartz and crystalline schists; also a great many calcareous shells (in particular of the genus *Discorbina*).

Station 145. N. B. 66° 49′. Ø. L. 11° 7′. 198 Fvn. (362 M.). 5.9°. En liden Prøve af graat, grovkornigt Ler. Mange Stene (veiende indtil 0.5 Gr.), bestaaende af Kvarts, Gneis o. fl.

Station 145. — Lat. 66° 49′ N., long. 11° 7′ E.; d. 198 fms. (362 m.); b.-t. 5.9°. A small sample of grey, coarse clay containing many pebbles (weighing up to 0.5 gr) of quartz, gneiss, &c.

Station 146. N. B. 65° 45′. Ø. L. 11° 22′. 180

Station 146. — Lat. 66° 45′ N., long. 11° 22′ E.;

Fvn. (329 M.). 6.2°. En liden Prøve af graat, grovkornigt Ler. Mange Stene (veiende indtil 0.6 Gr.), bestaaende af Kvarts og krystallinske Skifere.

d. 180 fms. (329 m.); b.-t. 6.2°. A small sample of grey, coarse clay containing many pebbles (the largest weighing 0.6 gr) of quartz and crystalline schists.

Station 147. N. B. 66° 49', Ø. L. 12° 8'. 142 Fvn. (260 M.). 6.2°. Graat, grovkornigt Ler. Faa og ganske smaa Stene (veiende indtil 0.1 Gr.), bestaaende af krystallinske Skifere. I Skraben fandtes mange Stene: Kvarts, Kvartsskifer, Glimmerskifer, mørk Lerskifer, Hornblendeskifer, rød Granit og stribet Granit. De største Stene var tilrundede paa Hjørnerne, men ellers temmelig ujevne; de mindre var tilrundede paa alle Kanter.

Station 147. — Lat. 66° 49' N., long. 12° 8' E.; d. 142 fms. (260 m.); b.-t. 6.2°. A grey, coarse clay containing only a few small pebbles (the largest weighing 0.1 gr) of crystalline schists. The dredge brought up numerous stones and pebbles, consisting of quartz, quartz-schist, mica-schist, dark clay-slate, hornblende-schist, red granite, and striped granite. The large stones were rounded at the corners, but otherwise comparatively irregular in form, whereas the small ones had all the sides rounded.

Station 148. N. B. 67° 27', Ø. L. 13° 25'. 150 Fvn. (274 M.). 5.0°. Graat, blødt Ler.

Station 148. — Lat. 67° 27' N., long. 13° 25' E.; d. 150 fms. (274 m.); b.-t. 5.0°. A grey, soft clay.

Station 149. N. B. 67° 52', Ø. L. 13° 58'. 135 Fvn. (247 M.). Graat, lyst, porøst, sandholdigt Ler med noget af en mørkere Slags. En liden Sten: Gneis.

Station 149. — Lat. 67° 52' N., long. 13° 58' E.; d. 135 fms. (247 m.). A light-grey, porous, sandy clay mixed with a little of a darker kind; it contained a small fragment of gneiss.

Station 150. N. B. 67° 11', Ø. L. 13° 21'. 189 Fvn. (346 M.). Graat Ler.

Station 150. — Lat. 67° 11' N., long. 13° 21' E.; d. 189 fms. (346 m.). A grey clay.

Station 151. N. B. 67° 15', Ø. L. 13° 4'. 127 Fvn. (232 M.). Stenbund.

Station 151. — Lat. 67° 15' N., long. 13° 4' E.; d. 127 fms. (232 m.). Bottom stony.

Station 152. N. B. 67° 18', Ø. L. 12° 46'. 125 Fvn. (229 M.). Haardt, graat, grovkornigt, ensartet Ler med noget af en løsere Slags. Talrige Glimmerblade. En liden Sten: Granit (veiende 0.2 Gr.).

Station 152. — Lat. 67° 18' N., long. 12° 46' E.; d. 125 fms. (229 m.). A hard, coarse, homogeneous, grey clay mixed with some comparatively porous; it contained numerous scales of mica, and a small fragment of granite weighing 0.2 gr.

Station 153. N. B. 67° 22', Ø. L. 12° 29'. 122 Fvn. (223 M.). Graat, grovkornigt, uensartet Ler med talrige Glimmerblade. Nogle Stene (veiende indtil 0.2 Gr.), bestaaende af krystallinske Skifere.

Station 153. — Lat. 67° 22' N., long. 12° 29' E.; d. 122 fms. (223 m.). A grey, coarse clay containing numerous scales of mica and a few pebbles (the largest weighing 0.2 gr) of crystalline schists.

Station 154. N. B. 67° 26', Ø. L. 12° 14'. 78 Fvn. (143 M.). Stenbund.

Station 154. — Lat. 67° 26' N., long. 12° 14' E.; d. 78 fms. (143 m.). Bottom stony.

Station 155. N. B. 67° 35', Ø. L. 11° 46'. 72 Fvn. (132 M.). 4.4°. Stenbund.

Station 155. — Lat. 67° 35' N., long. 11° 46' E.; d. 72 fms. (132 m.); b.-t. 4.4°. Bottom stony.

Station 156. N. B. 67° 40', Ø. L. 11° 26'. 90 Fvn. (165 M.). 4.7°. Stenbund.

Station 156. — Lat. 67° 40' N., long. 11° 26' E.; d. 90 fms. (165 m.); b.-t. 4.7°. Bottom stony.

Station 157. N. B. 67° 45', Ø. L. 11° 7'. 106 Fvn. (194 M.). 4.8°. Stenbund.

Station 157. — Lat. 67° 45' N., long. 11° 7' E.; d. 106 fms. (194 m.); b.-t. 4.8°. Bottom stony.

Station 158. N. B. 67° 49', Ø. L. 10° 49'. 102

Station 158. — Lat. 67° 49' N., long. 10° 49' E.;

Fvn. (187 M.). 4.6°. Graat, grovkornigt Ler. En Sten: hvid, forvitrende Granit (veiende 3 Gr.).

d. 102 fms. (187 m.); b.-t. 4.6°. A grey, coarse clay containing a fragment of white disintegrated granite, weight 3 gr.

Station 159. N. B. 67° 54', Ø. L. 10° 30'. 118 Fvn. (216 M.). 4.6°. Uensartet Blanding af Sand og graat Ler. Mange Stene (veiende indtil 1 Gr.), bestaaende af Granit, blød Lerskifer.

Station 159. — Lat. 67° 54' N., long. 10° 30' E.; d. 118 fms. (216 m.); b.-t. 4.6°. A mixture of sand and grey clay containing many pebbles (the largest weighing 1 gr) of granite and soft clay-slate.

Station 160. N. B. 67° 58', Ø. L. 10° 11'. 280 Fvn. (512 M.). 5.9°. Mørkgraat, sandholdigt Ler. Nogle Stene: Lerskifere.

Station 160. — Lat. 67° 58' N., long. 10° 11' E.; d. 280 fms. (512 m.); b.-t. 5.9°. A dark-grey, sabulous clay containing a few pebbles (clay-slate).

Station 161. N. B. 68° 3', Ø. L. 9° 53'. 592 Fvn. (1083 M.). — 1.1°. Graat Ler med noget fint Sand.

Station 161. — Lat. 68° 3' N., long. 9° 53' E.; d. 592 fms. (1083 m.); b.-t. — 1.1°. A grey clay mixed with fine sand.

Station 162. N. B. 68° 23', Ø. L. 10° 20'. 795 Fvn. (1454 M.). — 1.2°. Brunt Overgangsler. Nogle Stene (veiende indtil 3 Gr.), bestaaende af Kvartsit, Gneis.

Station 162. — Lat. 68° 23' N., long. 10° 20' E.; d. 795 fms. (1454 m.); b.-t. — 1.2°. A brown transition clay containing a few pebbles (the largest weighing 3 gr) of quartzite and gneiss.

Station 163. N. B. 68° 22', Ø. L. 10° 30'. 690 Fvn. (1262 M.). — 1.2°. Brunt, grovkornigt, sandholdigt Overgangsler med noget graat Underler. Mange Stene, bestaaende af Kvarts, Feldspath, Granit, Gneis.

Station 163. — Lat. 68° 22' N., long. 10° 30' E.; d. 690 fms. (1262 m.); b.-t. — 1.2°. A brown, coarse, sabulous transition clay mixed with a little grey clay; it contained many pebbles of quartz, feldspat, granite, gneiss.

Station 164. N. B. 68° 21', Ø. L. 10° 40'. 457 Fvn. (836 M.). — 0.7°. Graat, sandholdig Ler. Mange Stene.

Station 164. — Lat. 68° 21' N., long. 10° 40' E.; d. 457 fms. (836 m.); b.-t. — 0.7°. A grey, sabulous clay containing many pebbles.

Station 165. N. B. 68° 46', Ø. L. 10° 51'. 1470 Fvn. (2688 M.). — 1.2°. Biloculinler.

Station 165. — Lat. 68° 46' N., long. 10° 51' E.; d. 1470 fms. (2688 m.); b.-t. — 1.2°. Biloculina clay.

Station 166. N. B. 68° 40', Ø. L. 11° 40'. 406 Fvn. (742 M.). 0.1°. Graat, grovkornigt Ler. Mange Stene (veiende indtil 4 Gr.), bestaaende af krystallinske Skifere.

Station 166. — Lat. 68° 40' N., long. 11° 40' E.; d. 406 fms. (742 m.); b.-t. 0.1°. A grey, coarse clay containing many pebbles (the largest weighing 4 gr) of crystalline schists.

Station 167. N. B. 68° 37', Ø. L. 12° 2'. 79 Fvn. (144 M.). 6.4°. Stenbund.

Station 167. — Lat. 68° 37' N., long. 12° 2' E.; d. 79 fms. (144 m.); b.-t. 6.4°. Bottom stony.

Station 168. N. B. 68° 39', Ø. L. 11° 51'. 444 Fvn. (812 M.). 2.3°. Brunt Overgangsler.

Station 168. — Lat. 68° 39' N., long. 11° 51' E.; d. 444 fms. (812 m.); b.-t. 2.3°. A brown transition clay.

Station 169. N. B. 68° 36', Ø. L. 12° 53'. 72 Fvn. (132 M.). 5.4°. Stenbund.

Station 169. — Lat. 68° 36' N., long. 12° 53' E.; d. 72 fms. (132 m.); b.-t. 5.4°. Bottom stony.

Station 170. N. Br. 68° 32', Ø. L. 13° 18'. 67 Fvn. (123 M.). 5.2°. Stenbund.

Station 170. — Lat. 68° 32' N., long. 13° 18' E.; d. 67 fms. (123 m.); b.-t. 5.2°. Bottom stony.

Station 171. N. B. 69° 18', Ø. L. 14° 29'. 642 Fvn. (1174 M.). — 1.0°. To Lag i Bundprøven. Øverst brungraat Overgangsler, underst graat Ler. Ingen Stene.

Station 171. — Lat. 69° 18' N., long. 14° 29' E.; d. 642 fms. (1174 m.); b.-t. — 1.0°. Two layers in this sample, — the upper layer a brownish-grey transition and the under a grey clay. No pebbles.

Station 172. N. B. 69° 12′. Ø. L. 14° 47′. 81 Fvn. (148 M.). 5.3°. Stenbund.

Station 173. N. B. 69° 14′. Ø. L. 14° 43′. 240 Fvn. (439 M.). 5.3°. Stenbund.

Station 174. N. B. 69° 16′. Ø. L. 14° 38′. 337 Fvn. (616 M.). 4.2°. En liden Prøve af graat, uensartet, grovkornigt Ler. Mange Stene (veiende indtil 3 Gr.), bestaaende af Kvarts med Glimmer, krystallinske Skifere.

Station 175. N. B. 69° 17′, Ø. L. 14° 35′. 415 Fvn. (759 M.). 3.0°. Mørkgraat Ler. Mange Stene (veiende indtil 8 Gr.), bestaaende af Feldspath, Granit. Imellem Stationerne 175 og 176 fandtes i Skraben mange Stene: Kvarts, Gneis, Gneisgranit, Granit, Hornblendeskifer, Gabbro, Sandsten, Glimmerskifer, Lerskifer. De fleste af disse Stene var afrundede, nogle skarpkantede.

Station 176. N. B. 69° 18′, Ø. L. 14° 33′. 536 Fvn. (980 M.). — 0.2°. To Lag i Bundprøven. Øverst brunt, sandholdigt Overgangsler med mange guldglindsende, fine Glimmerblade. Nogle Globigeriner; en Del af Slægten *Lituola.* Dette brune Ler var gjennemvævet af Kiselspikuler af Svampe. Det underste Lag af Bundprøven bestod af graat Ler. Ingen Stene.

Station 177. N. B. 69° 25′, Ø. L. 13° 49′. 1443 Fvn. (2639 M.). — 1.2°. Graabrunt Overgangsler.

Station 178. N. B. 69° 29′. Ø. L. 12° 26′. 1578 Fvn. (2886 M.). — 1.3°. Biloculinler med mange Foraminiferer *(Globigerina, Lituola, Nonionina).*

Station 179. N. B. 69° 32′. Ø. L. 11° 10′. 1607 Fvn. (2939 M.). — 1.2°. Biloculinler.

Station 180. N. B. 69° 39′. Ø. L. 9° 55′. 1594 Fvn. (2915 M.). — 1.4°. Biloculinler.

Station 181. N. B. 69° 45′. Ø. L. 8° 43′. 1595 Fvn. (2917 M.). — 1.2°. En liden Prøve af smukt ensartet Biloculinler. 6—7 Biloculiner paa hver □-Cm. af den tørrede Bundprøve. Ingen Stene.

Station 182. N. B. 69° 51′. Ø. L. 7° 30′. 1684 Fvn. (3080 M.). — 1.2°. Smukt ensartet Biloculinler.

Station 183. N. B. 69° 59′, Ø. L. 6° 15′. 1710 Fvn. (3127 M.). — 1.3°. En liden Prøve af ensartet Biloculinler.

Station 184. N. B. 70° 4′. Ø. L. 9° 50′. 1547 Fvn.

Station 172. — Lat. 69° 12′ N., long. 14° 47′ E.; d. 81 fms (148 m.); b.-t. 5.3°. Bottom stony.

Station 173. — Lat. 69° 14′ N., long. 14° 43′ E.; d. 240 fms. (439 m.); b.-t. 5.3°. Bottom stony.

Station 174. — Lat. 69° 16′ N., long. 14° 38′ E.; d. 337 fms. (616 m.); b.-t. 4.2°. A small sample of grey, coarse clay containing many pebbles (the largest weighing 3^gr) of quartz and mica, and crystalline schists.

Station 175. — Lat. 69° 17′ N., long. 14° 35′ E.; d. 415 fms. (759 m.); b.-t. 3.0°. A dark-grey clay containing many pebbles (the largest weighing 8^gr) of feldspat, granite. — Between Stations 175 and 176, the dredge brought up numerous pebbles of quartz, gneiss, gneiss-granite, granite, hornblende-schist, gabbro, sandstone, mica-schist, clay-slate. Most of these pebbles were rounded, a few sharp-edged.

Station 176. — Lat. 69° 18′ N., long. 14° 33′ E.; 536 fms. (980 m.); b.-t. — 0.2°. Two layers, — above, a brown, sabulous, transition clay containing many delicate scales of mica and a few *Globigerinæ,* some belonging to the genus *Lituola.* This brown clay was interwoven with the siliceous spicules of sponges. The under layer consisted of grey clay. No pebbles.

Station 177. — Lat. 69° 25′ N., long. 13° 49′ E.; d. 1443 fms. (2639 m.); b.-t. — 1.2°. A greyish-brown transition clay.

Station 178. — Lat. 69° 29′ N., long. 12° 26′ E.; d. 1578 fms. (2886 m.); b.-t. — 1.3°. Biloculina clay containing many Foraminifera *(Globigerina, Lituola, Nonionina).*

Station 179. — Lat. 69° 32′ N., long. 11° 10′ E.; d. 1607 fms. (2939 m.); b.-t. — 1.2°. Biloculina clay.

Station 180. — Lat. 69° 39′ N., long. 9° 55′ E.; d. 1594 fms. (2915 m.); b.-t. — 1.4°. Biloculina clay.

Station 181. — Lat. 69° 45′ N., long. 8° 43′ E.; d. 1595 fms. (2917 m.); b.-t. — 1.2°. A small sample of homogeneous Biloculina clay, with 6 or 7 *Biloculinæ* to every □^cm of the dried sample. No pebbles.

Station 182. — Lat. 69° 51′ N., long. 7° 30′ E.; d. 1684 fms. (3080 m.); b.-t. — 1.2°. A fine sample of homogeneous Biloculina clay.

Station 183. — Lat. 69° 59′ N., long. 6° 15′ E.; d. 1710 fms. (3127 m.); b.-t. — 1.3°. A small sample of homogeneous Biloculina clay.

Station 184. — Lat. 70° 4′ N., long. 9° 50′ E.; d.

(2829 M.). — 1.3°. En liden Prove af Biloculinler med noget lysgraat Ler. Ingen Stene.

Station 185. N. B. 70° 3′. Ø. L. 13° 37′. 1485 Fvn. (2716 M.). — 1.4°. En liden Prøve af Biloculinler. Ingen Stene.

Station 186. N. B. 69° 56′. Ø. L. 14° 18′. 1418 Fvn. (2593 M.). — 1.3°. En liden Prøve af Biloculinler.

Station 187. N. B. 69° 51′. Ø. L. 14° 41′. 1335 Fvn. (2441 M.). — 1.1°. To Lag i Bundprøven. Øverst brunt Overgangsler, underst graat Ler.

Station 188. N. B. 69° 43′. Ø. L. 15° 29′. 1185 (2167 M.). — 1.3°. Brunt Overgangsler, ikke ensartet i Farve.

Station 189. N. B. 69° 41′. Ø. L. 15° 42′. 860 Fvn. (1573 M.). — 1.1°. To Lag i Bundprøven, øverst brunt Overgangsler, underst graat Ler. Ingen Stene.

Station 190. N. B. 69° 41′. Ø. L. 15° 51′. 870 Fvn. (1591 M.). — 1.2°. Grovkornigt, sandholdigt, brunt Ler. Mange uorganiske Dyrelevninger. Mange smaa Stene (veiende indtil 0.2 Gr.), bestaaende af Kvarts, krystallinske Skifere.

Station 191. N. B. 69° 44′. Ø. L. 16° 26′. 249 Fvn. (455 M.). 5.2°. Uensartet, graat, klumpet Ler. Nogle Stene.

Station 192. N. B. 69° 46′. Ø. L. 16° 15′. 649 Fvn. (1187 M.). — 0.7°. Bundprøven bestaar væsentlig af uorganiske Dyrelevninger, sammenkittede ved brunt Ler. Ingen Stene.

Station 193. N. B. 69° 44′. Ø. L. 16° 54′. 46 Fvn. (84 M.). 5.5°. Stenbund.

Station 194. N. B. 69° 43′. Ø. L. 17° 16′. 29 Fvn. (53 M.). 5.4°. Stenbund.

Station 195. N. B. 70° 55′. Ø. L. 18° 38′. 107 Fvn. (196 M.). 5.1°. Brungraat Ler med mange Dyrelevninger (ligner Station 192). Mange Stene (veiende indtil 3 Gr.), bestaaende af Kvarts, Kvartsit, Gneis. I Skraben fandtes: Gabbro, Granit med blaa Kvarts, Kvartsskifer, Hornblendeskifer, Glimmerskifer.

Station 196. N. B. 71° 2′. Ø. L. 18° 3′. 122 Fvn. (223 M.). 5.1°. Brunt Sandler med noget graat Ler, gjennemvævet af Kiselspikuler Svampe. Ingen Stene.

1547 fms. (2829 m.); b.-t. — 1.3°. A small sample of Biloculina clay along with a little light-grey clay. No pebbles.

Station 185. — Lat. 70° 3′ N., long. 13° 37′ E.; d. 1485 fms. (2716 m.); b.-t. — 1.4°. A small sample of Biloculina clay. No pebbles.

Station 186. — Lat. 69° 56′ N., long. 14° 18′ E.; d. 1418 fms. (2593 m.); b.-t. — 1.3°. A small sample of Biloculina clay.

Station 187. — Lat. 69° 51′ N., long. 14° 41′ E.; d. 1335 fms. (2441 m.); b.-t. — 1.1°. Two layers, — the upper layer a brown transition the under a grey clay.

Station 188. — Lat. 69° 43′ N., long. 15° 29′ E.; d. 1185 fms. (2167 m.); b.-t. — 1.3°. A brown transition clay varying in colour.

Station 189. — Lat. 69° 41′ N., long. 15° 42′ E.; d. 860 fms. (1573 m.); b.-t. — 1.2°. Two layers, — the upper layer a brown transition clay, the under a grey clay. No pebbles.

Station 190. — Lat. 69° 41′ N., long. 15° 51′ E.; d. 870 fms. (1591 m.); b.-t. — 1.2°. A brown, coarse, sabulous clay containing numerous inorganic animal remains and many pebbles (the largest weighing 0.2 gr) of quartz, crystalline schists.

Station 191. — Lat. 69° 44′ N., long. 16° 26′ E.; d. 249 fms. (455 m.); b.-t. 5.2°. A grey, lumpy, mixed clay. No pebbles.

Station 192. — Lat. 69° 46′ N., long. 16° 15′ E.; d. 649 fms. (1187 m.); b.-t. — 0.7°. This sample consisted almost exclusively of inorganic animal remains cemented together by means of a little brown clay. No pebbles.

Station 193. — Lat. 69° 44′ N., long. 16° 54′ E.; d. 46 fms. (84 m.); b.-t. 5.5°. Bottom stony.

Station 194. — Lat. 69° 43′ N., long. 17° 16′ E.; d. 29 fms. (53 m.); b.-t. 5.4°. Bottom stony.

Station 195. — Lat. 70° 55′ N., long. 18° 38′ E.; d. 107 fms. (196 m.); b.-t. 5.1°. A brownish-grey clay containing numerous inorganic animal remains, similar to those brought up at Station 192, and many pebbles (the largest weighing 3 gr) of quartz, quartzite, gneiss. The dredge brought up fragments of gabbro, granite with blue quartz, quartz-schist, hornblende-schist, and mica-schist.

Station 196. — Lat. 71° 2′ N., long. 18° 3′ E.; d. 122 fms. (223 m.); b.-t. 5.1°. A brown, sabulous clay along with a little grey clay, interwoven with siliceous spicules of sponges. No pebbles.

Station 197. N. B. 71° 7'. Ø. L. 17° 28'. 138 Fvn. (252 M.). 5.2°. Stenbund.

Station 198. N. B. 71° 13'. Ø. L. 16° 52'. 226 Fvn. (413 M.). 3.8°. Stenbund.

Station 199. N. B. 71° 18'. Ø. L. 16° 17'. 525 Fvn. (960 M.). — 0.6°. Stenbund.

Station 200. N. B. 71° 25'. Ø. L. 15° 41'. 620 Fvn. (1134 M.). — 1.0°. Brunt, sandholdigt Overgangsler med et Underlag af mørkgraat Ler. Nogle smaa Stene, bestaaende af krystallinske Skifere.

Station 201. N. B. 71° 31'. Ø. L. 15° 28'. 647 Fvn. (1183 M.). — 1.1°. Brunt, sandholdigt Overgangsler med noget blaagraat Underler. En Sten: Kvarts.

Station 202. N. B. 71° 31'. Ø. L. 14° 40'. 803 Fvn. (1468 M.). — 1.1°. Ler (?).

Station 203. N. B. 71° 31'. Ø. L. 13° 54'. 901 Fvn. (1648 M.). — 1.5°. En liden Prøve af graabrunt, fint Overgangsler, uensartet med Hensyn til Farven. Mange Stene (veiende indtil 3 Gr.), bestaaende af Kvarts, Gneis, Granit.

Station 204. N. B. 70° 57'. Ø. L. 13° 34'. 1266 Fvn. (2315 M.). — 1.1°. Biloculinler med noget mørkere brunt Ler. Ingen Stene.

Station 205. N. B. 70° 51'. Ø. L. 13° 3'. 1287 Fvn. (2354 M.). — 1.2°. Smukt Biloculinler. 1—2 Biloculiner paa hver □-Cm. af den tørrede Bundprøve. Mange af Slægten *Lituola* og *Globigerina*, enkelte af *Nonionina*. Ingen Stene. En Del af Bundprøven var stærkt oxyderet.

Station 206. N. B. 70° 45'. Ø. L. 14° 36'. 1248 Fvn. (2282 M.). — 1.1°. Biloculinler. Faa Biloculiner og Globigeriner. Ingen Stene.

Station 207. N. B. 70° 33'. Ø. L. 15° 50'. 1111 Fvn. (2032 M.). — 1.1°. Biloculinler. Nogle Stene (veiende indtil 0.2 Gr.), bestaaende af krystallinske Skifere.

Station 208. N. B. 70° 21'. Ø. L. 16° 57'. 675 Fvn. (1234 M.). — 1.0°. Brunt porøst, sandholdigt Overgangsler. Mange Stene (veiende indtil 0.5 Gr.), bestaaende af Kvarts, krystallinske Skifere, Hornblende (?) og Feldspath.

Station 209. N. B. 70° 19'. Ø. L. 17° 9'. 126 Fvn. (230 M.). 5.2°. Stenbund

Station 197. — Lat. 71° 7' N., long. 17° 28' E.; d. 138 fms. (252 m.); b.-t. 5.2°. Bottom stony.

Station 198. — Lat. 71° 13' N., long. 16° 52' E.; d. 226 fms. (413 m.); b.-t. 3.8°. Bottom stony.

Station 199. — Lat. 71° 18' N., long. 16° 17' E.; d. 525 fms. (960 m.); b.-t. — 0.6°. Bottom stony.

Station 200. — Lat. 71° 25' N., long. 15° 41' E.; d. 620 fms. (1134 m.); b.-t. — 1.0°. A brown, sabulous transition clay with an under layer of dark-grey clay; it contained a few pebbles (crystalline schists).

Station 201. — Lat. 71° 31' N., long. 15° 28' E.; d. 647 fms. (1183 m.); b.-t. — 1.1°. A brown, sabulous transition clay with a thin under layer of blue clay; it contained a small fragment of quartz.

Station 202. — Lat. 71° 31' N., long. 14° 40' E.; d. 803 fms. (1468 m.); b.-t. — 1.1°. Clay (?).

Station 203. — Lat. 71° 31' N., long. 13° 54' E.; d. 901 fms. (1648 m.); b.-t. — 1.5°. A small sample of a fine, greyish-brown transition clay, varying in colour; it contained many pebbles (weighing up to 3^{gr}) of quartz, gneiss, granite.

Station 204. — Lat. 70° 57' N., long. 13° 34' E.; d. 1266 fms. (2315 m.); b.-t. — 1.1°. Biloculina clay along with a little dark-brown clay. No pebbles.

Station 205. — Lat. 70° 51' N., long. 13° 3' E.; d. 1287 fms. (2354 m.); b.-t. — 1.2°. A fine sample of Biloculina clay (1 or 2 *Biloculinæ* to every □ cm. of the dried sample) containing many shells of the genera *Lituola* and *Globigerina*, and a few of the genus *Nonionina*. No pebbles. A portion of this sample had undergone oxidation.

Station 206. — Lat. 70° 45' N., long. 14° 36' E.; d. 1248 fms. (2282 m.); b.-t. — 1.1° Biloculina clay containing but few *Biloculinæ* and *Globigerinæ*. No pebbles.

Station 207. — Lat. 70° 33' N., long. 15° 50' E.; d. 1111 fms. (2032 m.); b.-t. — 1.1°. Biloculina clay containing a few pebbles (weighing up to 0.2^{gr}) of crystalline schists.

Station 208. — Lat. 70° 21' N., long. 16° 57' E.; d. 675 fms. (1234 m.); b.-t. — 1.0°. A brown, porous, sandy transition clay containing many pebbles (weighing up to 0.5^{gr}), of quartz, crystalline schists, hornblende (?), and feldspar.

Station 209. — Lat. 70° 19' N., long. 17° 9' E.; d. 126 fms. (230 m.); b.-t. 5.2°. Bottom stony.

Station 210. N. B. 70° 17′, Ø. L. 17° 20′. 137 Fvn. (251 M.). 6.0°. Stenbund.

Station 211. N. B. 70° 15′, Ø. L. 17° 31′. 129 Fvn. (236 M.). 6.0°. En liden Prøve af grøngraat Ler, gjennemvævet af Kiselspikuler af Svampe. Mange Skalbrudstykker og hele Skaller af kalkafsondrende Dyr. Ingen Stene.

Station 212. N. B. 70° 12′, Ø. L. 17° 41′. 142 Fvn. (260 M.). 5.8°. Sand og Ler (?).

Station 213. N. B. 70° 23′, Ø. L. 2° 30′. 1760 Fvn. (3219 M.). — 1.2°. Kun Spor af Biloculinler, overveiende *graat fint*, meget plastisk Ler (underliggende Lag).

Station 214. N. B. 70° 39′, Ø. L. 0° 0′. 1750 Fvn. (3200 M.). — 1.2°. To Lag i Bundprøven. Øverst Biloculinler, underst *graat* fint, meget plastisk Ler. En Sten: krystallinsk Skifer (veiende 0.3 Gr.).

Station 215. N. B. 70° 53′, V. L. 2° 0′. 1665 Fvn. (3045 M.) — 1.2°. Biloculinler med graat Underler.

Station 216. N. B. 70° 58′, Ø. L. 3° 40′. 1231 Fvn. (2251 M.). — 1.3°. Biloculinler med graat Underler.

Station 217. N. B. 71° 0′, V. L. 5° 9′. 829 Fvn. (1516 M.). — 1.3°. Sandholdigt Biloculinler med nogle faa Biloculiner. Nogle Stene.

Station 218. N. B. 71° 1′, V. L. 6° 0′. 968 Fvn. (1770 M.). — 1.3°. Eiendommeligt, uensartet, sandholdigt Biloculinler med nogle faa Biloculiner, men temmelig mange Globigeriner. Et lidet Stykke Stenkul (?).

Station 219. N. B. 71° 2′, V. L. 6° 51′. 796 Fvn. (1456 M.). — 1.2°. Biloculinler med mange Foraminiferer, væsentlig Globigeriner.

Station 220. N. B. 71° 2′, V. L. 7° 26′. 1275 Fvn. (2332 M.). — 1.5°. Stenbund (?).

Station 221. N. B. 71° 2′, V. L. 7° 35′. 1060 Fvn. (1938 M.). — 1.3°. Stenbund.

Station 222. N. B. 71° 2′, V. L. 7° 46′. 654 Fvn. (1196 M.). — 1.0°. Stenbund.

Station 222 a. N. B. 71° 3′, V. L. 7° 54′. 144 Fvn. (263 M.). Graasort vulkansk Sandler.

Station 222 b. N. B. 71° 0′, V. L. 8° 29′. 20

Station 210. — Lat. 70° 17′ N., long. 17° 20′ E.; d. 137 fms. (251 m.); b.-t. 6.0°. Bottom stony.

Station 211. — Lat. 70° 15′ N., long. 17° 31′ E.; d. 129 fms. (236 m.); b.-t. 6.0°. A small sample of greenish-grey clay interwoven with the siliceous spicules of sponges, and containing besides many fragments of calcareous shells and whole shells of lime-secreting animals. No pebbles.

Station 212. — Lat. 70° 12′ N., long. 17° 41′ E.; d. 142 fms. (260 m.); b.-t. 5.8°. Sand and clay (?).

Station 213. — Lat. 70° 23′ N., long. 2° 30′ E.; d. 1760 fms. (3219 m.); b.-t. — 1.2°. A very little Biloculina clay, the remainder of the sample consisting of a *fine, grey,* exceedingly plastic clay (the under layer).

Station 214. — Lat. 70° 39′ N., long. 0° 0′; d. 1750 fms. (3200 m.); b.-t. — 1.2°. Two layers; the upper Biloculina clay, the under a fine, *grey,* exceedingly plastic clay; the sample contained a small fragment of crystalline schist, weighing 0.3 gr.

Station 215. — Lat. 70° 53′ N., long. 2° 0′ W.; d. 1665 fms. (3045 m.); b.-t. — 1.2°. Biloculina clay with a grey under layer.

Station 216. — Lat. 70° 58′ N., long. 3° 40′ W.; d. 1231 fms. (2251 m.); b.-t. — 1.3°. Biloculina clay with a grey under layer.

Station 217. — Lat. 71° 0′ N., long. 5° 9′ W.; d. 829 fms. (1516 m.); b.-t. — 1.3°. A brown, sabulous clay containing a few *Biloculinæ* and a few pebbles.

Station 218. — Lat. 71° 1′ N., long. 6° 0′ W.; d. 968 fms. (1770 m.); b.-t. — 1.3°. A peculiar, heterogeneous, brown, sandy clay containing a few *Biloculinæ* and a good many *Globigerinæ;* also a small fragment of coal (?).

Station 219. — Lat. 71° 2′ N., long. 6° 51′ W.; d. 796 fms. (1456 m.); b.-t. — 1.2°. Biloculina clay containing many Foraminifera, chiefly *Globigerinæ.*

Station 220. — Lat. 71° 2′ N., long. 7° 26′ W.; d. 1275 fms. (2332 m.); b.-t. — 1.5°. Bottom stony.

Station 221. — Lat. 71° 2′ N., long. 7° 35′ W.; d. 1060 fms. (1938 m.); b.-t. — 1.3°. Bottom stony.

Station 222. — Lat. 71° 2′ N., long. 7° 46′ W.; d. 654 fms. (1196 m.); b.-t. — 1.0°. Bottom stony.

Station 222 a. — Lat. 71° 3′ N., long. 7° 54′ W.; d. 144 fms. (263 m.). A greyish-black, volcanic, sabulous clay.

Station 222 b. — Lat. 71° 0′ N., long. 8° 29′ W.;

Fvn. (37 M.). 1.2°. Graasort vulkansk Sandler.

Station 223. N. B. 70° 54′, V. L. 8° 24′. 70 Fvn. (128 M.). —0.6°. Graasort, løst Ler. Nogle Stene, væsentlig bestaaende af basaltisk Lava.

Station 224. N. B. 70° 51′, V. L. 8° 20′. 95 Fvn. (174 M.). —0.6°. Graasort, vulkansk Sand og Sandler. Faa Stene. Mange smaa Brudstykker af lysgrønt Olivin.

Station 225. N. B. 70° 58′, V. L. 8° 4′. 195 Fvn. (357 M.). — 0.6°. Graasort vulkansk Sandler (lig det foregaaende). Ingen Stene.

Station 226. N. B. 70° 59′, V. L. 7° 51′. 340 Fvn. (622 M.). — 0.6°. Graasort, vulkansk Sandler.

Station 227. N. B. 71° 13′, V. L. 7° 33′. 1040 Fvn. (1902 M.). — 1.5°. Mørkbrunt Ler.

Station 228. N. B. 71° 12′, V. L. 8° 9′. 933 Fvn. (1706 M.). — 1.5°. Stenbund.

Station 229. N. B. 71° 12′, V. L. 8° 55′. 732 Fvn. (1339 M.). — 1.3°. Mørkbrunt Ler. Ingen Biloculiner og faa andre Foraminiferer. Nogle smaa Stene, væsentlig bestaaende af vulkanske Slakker med Olivin.

Station 230. N. B. 71° 16′, V. L. 9° 10′. 854 Fvn. (1562 M.). — 1.3°. Mørkbrunt Ler. Et Par Stene (veiende indtil 1.5 Gr.), bestaaende af basaltisk Lava.

Station 231. N. B. 71° 21′, V. L. 9° 23′. 1032 Fvn. (1887 M.). — 1.3°. Haardt, lysbrunt, uensartet Ler. Faa Biloculiner, nogle Globigeriner. Ingen af Slægten *Lituola*. Flere smaa Stene (veiende indtil 0.3 Gr.), bestaaende af Kvarts, Sandsten (?).

Station 232. N. B. 71° 10′, V. L. 8° 48′. 780 Fvn. (1426 M.). — 1.3°. Blanding af brunt og graat Ler. Ingen Stene.

Station 233. N. B. 71° 8′, V. L. 8° 46′. 580 Fvn. (1061 M.). — 1.4°. Gulbrunt Ler.

Station 234. N. B. 71° 6′, V. L. 8° 38′. 259 Fvn. (474 M.). — 1.0°. Graasort, tung Sandler. Flere Stene (veiende indtil 0.3 Gr.), bestaaende af vulkanske Slakker, porøs, basaltisk Lava.

Station 235. N. B. 70° 59′, V. L. 8° 55′. 98 Fvn. (179 M.). 0.0°. Stenbund.

d. 20 fms. (37 m.): b.-t. 1.2°. A greyish-black, volcanic sabulous, clay.

Station 223. — Lat. 70° 54′ N., long. 8° 24′ W.; d. 70 fms. (128 m.); b.-t. — 0.6°. A greyish-black, friable clay containing a few pebbles, chiefly of basaltic lava.

Station 224. — Lat. 70° 51′ N., long. 8° 20′ W.; d. 95 fms. (174 m.); b.-t. —0.6°. Greyish-black, volcanic sand and sandy clay containing many small fragments of olivine, but very few other pebbles.

Station 225. — Lat. 70° 58′ N., long. 8° 4′ W.; d. 195 fms. (357 m.); b.-t. —0.6°. A greyish-black, volcanic sabulous clay similar to the foregoing. No pebbles.

Station 226. — Lat. 70° 59′ N., long. 7° 51′ W.; d. 340 fms. (622 m.); b.-t. — 0.6°. A greyish-black, volcanic, sabulous clay.

Station 227. — Lat. 71° 13′ N., long. 7° 33′ W.; d. 1040 fms. (1902 m.); b.-t. — 1.5°. A dark-brown clay.

Station 228. — Lat. 71° 12′ N., long. 8° 9′ W.; d. 933 fms. (1706 m.); b.-t. — 1.5°. Bottom stony.

Station 229. — Lat. 71° 12′ N., long. 8° 55′ W.; d. 732 fms. (1339 m.); b.-t. — 1.3°. A dark-brown clay containing a very few Foraminifera (no *Biloculinæ)* and a few pebbles, chiefly of scoriæ with olivine.

Station 230. — Lat. 71° 16′ N., long. 9° 10′ W.; d. 854 fms. (1562 m.); b.-t. — 1.3°. A dark-brown clay containing one or two small fragments (weighing 1.5^{gr}) of basaltic lava.

Station 231. — Lat. 71° 21′ N., long. 9° 23′ W.; d. 1032 fms. (1887 m.); b.-t. — 1.3°. A hard, light-brown, heterogeneous clay containing: — Very few *Biloculinæ;* a few *Globigerinæ* (none of the genus *Lituola);* divers pebbles (the largest weighing 0.3^{gr}) of quartz, sandstone (?).

Station 232. — Lat. 71° 10′ N., long. 8° 48′ W.; d. 780 fms. (1426 m.); b.-t. — 1.3°. A mixture of brown and grey clay. No pebbles.

Station 233. — Lat. 71° 8′ N., long. 8° 46′ W.; d. 580 fms. (1061 m.); b.-t. — 1.4°. A yellowish-brown clay.

Station 234. — Lat. 71° 6′ N., long. 8° 38′ W.; d. 259 fms. (474 m.); b.-t. — 1.0°. A greyish-black, heavy, sabulous clay containing divers pebbles (the largest weighing 0.3^{gr}), of scoriæ, and porous, basaltic lava.

Station 235. — Lat. 70° 59′ N., long. 8° 55′ W.; d. 98 fms. (179 m.); b.-t. 0.0°. Bottom stony.

Station 236. N. B. 70° 58′. V. L. 9° 2′. 156 Fvn. (285 M.). Graasort vulkansk Sandler (lig 234). Ingen Stene.

Station 237. N. B. 70° 41′. V. L. 10° 10′. 263 Fvn. (481 M.). — 0.3°. Brunt, løst, sandholdigt Ler. Mange Stene, bestaaende af Olivin, Lava og smukke Krystaller af Augit. I Skraben fandtes en Mængde Stene: Kvarts, Glimmerskifer med Lav paa Overfladen, sort Lava med Feldspath-Krystaller, do. do. med smaa, runde, tomme Blærerum (denne Sten var rund), grøn kloritisk Skifer med Kispunkter, Lava med Olivin, Anorthit (?), Augit og Hornblende; sort, tæt Lava med Punkter af Magnetjern, brun, tæt Lava, Mandelsten, brun Lava med Rustpunkter, grovkornig Granit og krystallinske Skifere. Desforuden fandtes i Skraben mange smukke Krystaller af Augit, Hornblende og Olivin.

Station 238. N. B. 70° 13′. V. L. 10° 54′. 845 Fvn. (1545 M.). — 1.1°. Biloculinler (?).

Station 239. N. B. 69° 35′. V. L. 11° 13′. 1050 Fvn. (1920 M.). — 1.0°. Lysbrunt Biloculinler.

Station 240. N. B. 69° 2′. V. L. 11° 26′. 1004 Fvn. (1836 M.). — 1.1°. Lysbrunt Biloculinler med en Mængde forskjellige Foraminiferer, væsentlig Globigeriner. Et Par ganske smaa Stene, bestaaende af mørk Kvarts (veiende indtil 0.1 Gr.).

Station 241. N. B. 68° 41′. V. L. 10° 54′. 1119 Fvn. (2046 M.). — 1.4°. Smukt, lysbrunt Biloculinler (lig det foregaaende) med en Mængde Foraminiferer. En ganske liden Sten (veiende omtrent 0.02 Gr.).

Station 242. N. B. 68° 36′. V. L. 8° 40′. 1033 Fvn. (1889 M.). — 1.3°. Biloculinler, noget grovkornigt, faa Biloculiner, men mange Globigeriner. Ingen af Slægten *Lituola*, mange *Nonionina*.

Station 243. N. B. 68° 32′. V. L. 6° 26′. 1385 Fvn. (2533 M.). — 1.3°. Biloculinler med mange Foraminiferer.

Station 244. N. B. 68° 28′. V. L. 4° 17′. 1951 Fvn. (3568 M.). — 1.3°. Biloculinler, lig det foregaaende. Af Foraminiferer fandtes væsentlig Globigeriner.

Station 245. N. B. 68° 21′. V. L. 2° 5′. 2005 Fvn. (3667 M.). — 1.4°. I Biloculinler fra denne Station fandtes en Lagdannelse; det øverste Lag af Bundprøven var et yderst fint, plastisk, brunt Ler uden Foraminiferer. Det underste Lag bestod af lysere brunt, porøst

Station 236. — Lat. 70° 58′ N., long. 9° 2′ W.; d. 156 fms. (285 m.). A greyish-black, volcanic, sabulous clay similar to that brought up at Station 234. No pebbles.

Station 237. — Lat. 70° 41′ N., long. 10° 10′ W.; 263 fms. (481 m.); b.-t. — 0.3°. A brown, sabulous, friable clay containing many particles of olivine and beautiful crystals of augite. The dredge brought up great numbers of pebbles, as quartz, mica-schist coated over with lichen black lava with crystals of feldspar, black lava with small round, empty vesicles (this fragment was globular in form), green chloritic schist with pyritic granules, lava with olivine, anorthite (?), augite, hornblende, black compact lava with grains of magnetite, brown compact lava, amygdaloid, brown lava with specks of rust, coarse-grained granite, and crystalline schists. Moreover, the dredge contained many beautiful crystals of augite, hornblende, and olivine.

Station 238. — Lat. 70° 13′ N., long. 10° 54′ W.; d. 845 fms. (1545 m.); b.-t. — 1.1°. Biloculina clay (?).

Station 239. — Lat. 69° 35′ N., long. 11° 13′ W.; d. 1050 fms. (1920 m.); b.-t. — 1.0°. A light-brown Biloculina clay.

Station 240. — Lat. 69° 2′ N., long. 11° 26′ W.; d. 1044 fms. (1836 m.); b.-t. — 1.1°. A light-brown Biloculina clay containing great numbers of Foraminifera, chiefly *Globigerinæ*, and one or two fine particles of quartz, the largest weighing 0.1 . .

Station 241. — Lat. 68° 41′ N., long. 10° 54′ W.; d. 1119 fms. (2046 m.); b.-t. — 1.4°. A fine sample of light-brown Biloculina clay, similar to the foregoing, containing great numbers of Foraminifera, and a small pebble, weighing about 0.02 gr.

Station 242. — Lat. 68° 36′ N., long. 8° 40′ W.; d. 1033 fms. (1889 m.); b.-t. — 1.3°. A somewhat coarsely granulated Biloculina clay containing many *Globigerinæ* and *Nonioninæ*, but very few *Biloculinæ*; the genus *Lituola* was not represented

Station 243. — Lat. 68° 32′ N., long. 6° 26′ W.; d. 1385 fms. (2533 m.); b.-t. — 1.3°. Biloculina clay containing many Foraminifera.

Station 244. — Lat. 68° 28′ N., long. 4° 17′ W.; d. 1951 fms. (3568 m.); b.-t. — 1.3°. Biloculina clay containing many Foraminifera, chiefly *Globigerinæ*.

Station 245. — Lat. 68° 21′ N., long. 2° 5′ W.; d. 2005 fms. (3667 m.); b.-t. — 1.4°. The sample of Biloculina clay that came up at this Station, was in two layers; the upper a brown, exceedingly fine and plastic clay, without any Foraminifera, the under a lighter brown, porous clay

Ler med en Mængde Globigeriner, Biloculiner og andre Foraminiferer.

Station 246. N. B. 68° 14', Ø. L. 0° 6'. 1592 Fvn. (2911 M.). — 1.3°. Biloculinler med to Lag, ligesom det foregaaende. Ingen Stene.

Station 247. N. B. 68° 5', Ø. L. 2° 24'. 1120 Fvn. (2048 M.). — 1.2°. Biloculinler.

Station 248. N. B. 67° 56', Ø. L. 4° 11'. 778 Fvn. (1423 M.). — 1.4°. Biloculinler.

Station 249. N. B. 68° 12', Ø. L. 6° 35'. 1063 Fvn. (1944 M.). — 1.3°. Biloculinler med noget mørkere brunt Ler.

Station 250. N. B. 68° 10', Ø. L. 9° 20'. 1150 Fvn. (2103 M.). — 1.4°. To Lag i Bundprøven, øverst lysbrunt Overgangsler, underst graat Ler. Ingen Biloculiner. Mange Stene, væsentlig bestaaende af krystallinske Skifere.

Station 251. N. B. 68° 6', Ø. L. 9° 44'. 634 Fvn. (1159 M.). — 1.3°. To Lag i Bundproven. Øverst sandholdigt, brunt Overgangsler med nogle Biloculiner og Globigeriner. Mange Stene (veiende indtil 1 Gr.), bestaaende af Gneis, Feldspath, Kvarts.

Station 253, Vestfjorden. 263 Fvn. (481 M.). 3.2°. Graagronligt, fast og ensartet Ler. Ingen Stene.

Station 254. N. B. 67° 27', Ø. L. 13° 25'. 143 Fvn. (262 M.). 5.8°. Ensartet, graat Ler. Flere Stene.

containing great numbers of *Globigerinæ*, *Biloculinæ*, and other Foraminifera.

Station 246. — Lat. 68° 14' N., long. 0° 6' E.; d. 1592 fms. (2911 m.); b.-t. — 1.3°. A sample of Biloculina clay in two layers, like the foregoing. No pebbles.

Station 247. — Lat. 68° 5' N., long. 2° 4' E.; d. 1120 fms. (2048 m.); b.-t. — 1.2°. Biloculina clay.

Station 248. — Lat. 67° 56' N., long. 4° 11' E.; d. 778 fms. (1423 m.); b.-t. — 1.4°. Biloculina clay.

Station 249. — Lat. 68° 12' N., long. 6° 35' E.; d. 1063 fms. (1944 m.); b.-t. — 1.3°. Biloculina clay along with a little of a darker tint.

Station 250. — Lat. 68° 10' N., long. 9° 20' E.; d. 1150 fms. (2103 m.); b.-t. — 1.4°. Two layers, — the upper a light-brown transition clay, the under a grey clay, containing together many pebbles, chiefly of crystalline schists. No *Biloculinæ*.

Station 251. — Lat. 68° 6' N., long. 9° 44' E.; d. 634 fms. (1159 m.); b.-t. — 1.3°. Two layers, — the upper a brown, sabulous transition clay containing a few *Biloculinæ* and *Globigerinæ* and many pebbles (the largest weighing 1 gr) of gneiss, feldspar, quartz.

Station 253 (Vestfjorden). — D. 263 fms. (481 m.); b.-t. 3.2°. A firm, greyish-green, homogeneous clay. No pebbles.

Station 254. — Lat. 67° 27' N., long. 13° 25' E.; d. 143 fms. (262 m.); b.-t. 5.8°. A grey, homogeneous clay containing divers pebbles.

Bundprøver fra 1878.

Samples of the Bottom (1878).

Station 255. N. B. 68° 12', Ø. L. 15° 40'. 341 Fvn. (624 M.). 6.5°. Blaagraat Ler med en Mængde uorganiske Dyrelevninger. Ingen Stene.

Station 256. N. B. 70° 8', Ø. L. 23° 4'. 225 Fvn. (411 M.). 4.0°. Graagrønt, ensartet Ler. Faa Stene (veiende indtil 0.2 Gr.), bestaaende af Kvarts og krystallinske Skifere.

Station 257. N. B. 70° 4', Ø. L. 23° 2'. 160

Station 255. — Lat. 68° 12' N., long. 15° 40' E.; d. 341 fms. (624 m.); b.-t. 6.5°. A grey clay containing great numbers of inorganic animal remains. No pebbles.

Station 256. — Lat. 70° 8' N., long. 23° 4' E.; d. 225 fms. (411 m.); b.-t. 4.0°. A greyish-green homogeneous clay containing a few pebbles (the largest weighing 0.2 gr) of quartz and crystalline schists.

Station 257. — Lat. 70° 4' N., long. 23° 2' E.;

Fvn. (293 M.). 3.9°. Ensartet, graat Ler. Ingen Stene.

d. 160 fms. (293 m.); b.-t. 3.9°. A grey, homogeneous clay. No pebbles.

Station 258. N. B. 70° 13′, Ø. L. 23° 3′. 230 Fvn. (421 M.). 4.0°. Grøngraat Ler.

Station 258. — Lat. 70° 13′ N., long. 23° 3′ E.; d. 230 fms. (421 m.); b.-t. 4.0°. A greenish-grey clay.

Station 259. N. B. 70° 49′, Ø. L. 25° 59′. 80 Fvn. (146 M.). 4.1°. En liden Prøve af grøngraat Ler, lignende Rhabdamminaleret. En Mængde Dyrelevninger: Koraller, Skaller af Slægten *Astarte* og Rør af Annelider *(Spiochetopterus)*. Mange Stene, bestaaende af Kvartsit, Glimmerskifer med Granat, Gneis, Granit.

Station 259. — Lat. 70° 49′ N., long. 25° 59′ E.; d. 80 fms. (146 m.); b.-t. 4.1°. A small sample of green, glistening Rhabdammina clay containing great numbers of animal remains, as coral, shells of the genus *Astarte* and tubes of Annelids *(Spiochetopterus)*; also many pebbles, consisting of quartzite, mica schist with garnets, gneiss, granite.

Station 260. N. B. 70° 55′, Ø. L. 26° 11′. 127 Fvn. (232 M.). 3.5°. Ler.

Station 260. — Lat. 70° 55′ N., long. 26° 11′ E.; d. 127 fms. (232 m.); b.-t. 3.5°. Bottom clay.

Station 261. N. B. 70° 47′, Ø. L. 28° 30′. 127 Fvn. (232 M.). 2.8°. Ensartet, lysgraat Ler. Ingen Stene.

Station 261. — Lat. 70° 47′ N., long. 28° 30′ E.; d. 127 fms. (232 m.); b.-t. 2.8°. A light-grey, homogeneous clay. No pebbles.

Station 262. N. B. 70° 36′, Ø. L. 32° 35′. 148 Fvn. (271 M.). 1.9°. Brunt, ensartet Sandler. Ingen Stene.

Station 262. — Lat. 70° 36′ N., long. 32° 35′ E.; d. 148 fms. (271 m.); b.-t. 1.9°. A brown, homogeneous, sandy clay. No pebbles.

Station 263. N. B. 70° 44′, Ø. L. 34° 14′. 121 Fvn. (221 M.). 1.9°. Grønliggraat, temmelig fast Ler. Ingen Stene.

Station 263. — Lat. 70° 44′ N., long. 34° 14′ E.; d. 121 fms. (221 m.); b.-t. 1.9°. A greenish-grey, comparatively firm clay. No pebbles.

Station 264. N. B. 70° 56′, Ø. L. 35° 37′. 86 Fvn. (157 M.). 1.9°. Løst, grøngraat Rhabdamminaler med noget fastere, graat Underler.

Station 264. — Lat. 70° 56′ N., long. 35° 37′ E.; d. 86 fms. (157 m.); b.-t. 1.9°. A friable, greenish-grey Rhabdammina clay, with a thin under layer of a somewhat firmer grey clay.

Station 266. N. B. 71° 27′, Ø. L. 35° 39′. 130 Fvn. (238 M.). 0.6°. Øverst i Bundprøven et tyndt Lag af grøngraat Rhabdamminaler, under graat, fastere Ler. Mange Annelider *(Spiochetopterus)*.

Station 266. — Lat. 71° 27′ N., long. 35° 39′ E.; d. 130 fms. (238 m.); b.-t. 0.6°. Two layers, — the upper consisting of a little greenish-grey Rhabdammina clay, the under of a firmer grey clay; this sample contained many Annelids *(Spiochetopterus)*.

Station 267. N. B. 71° 42′, Ø. L. 37° 1′. 148 Fvn. (271 M.). — 1.4°. Løst Rhabdamminaler med noget graat Underler. Mange Annelider og Skaller af Slægten *Astarte*. Ingen Stene.

Station 267. — Lat. 71° 42′ N., long. 37° 1′ E.; d. 148 fms. (271 m.); b.-t. — 1.4°. A friable Rhabdammina clay on a thin layer of grey clay, containing many Annelids and shells of the genus *Astarte*. No pebbles.

Station 268. N. B. 71° 36′, Ø. L. 36° 18′. 130 Fvn. (238 M.). — 1.0°. Løst Rhabdamminaler.

Station 268. — Lat. 71° 36′ N., long. 36° 18′ E.; d. 130 fms. (238 m.); b.-t. — 1.0°. A friable Rhabdammina clay.

Station 269. N. B. 72° 11′, Ø. L. 36° 40′. 138 Fvn. (252 M.). — 1.2°. Rhabdamminaler (ligner 264). Mange Annelider. Smaa Stykker af Stenkul. Ingen Stene.

Station 269. — Lat. 72° 11′ N., long. 36° 40′ E.; d. 138 fms. (252 m.); b.-t. — 1.2°. Rhabdammina clay (similar to the sample brought up at Station 264) containing small fragments of coal, but no pebbles.

Station 270. N. B. 72° 27′, Ø. L. 35° 1′. 136 Fvn. (249 M.). 0.0°. Ensartet, grøngraat Rhabdamminaler. Mange Annelider. Ingen Stene.

Station 270. — Lat. 72° 27′ N., long. 15° 1′ E.; d. 136 fms. (249 m.); b.-t. 0.0°. A greyish-green, homogeneous Rhabdammina clay containing many Annelids. No pebbles.

Station 271. N. B. 72° 38′, Ø. L. 33° 50′. 160 Fvn. (293 M.). 0.7°. En liden Prøve af ensartet, grøngraat Ler. Mange Annelider. Ingen Stene.

Station 272. N. B. 73° 11′, Ø. L. 33° 3′. 113 Fvn. (207 M.). 1.5°. Grøngraat Rhabdamminaler med noget fastere graat Underler. Nogle Stene (veiende indtil 1.0 Gr.), bestaaende af mørk Kalksten.

Station 273. N. B. 73° 25′, Ø. L. 31° 30′. 197 Fvn. (360 M.). 2.2°. Grønliggraat Rhabdammina-Ler. Mange Skaller *(Astarte)*. Mange ganske smaa Stene, hovedsagelig bestaaende af Kvarts.

Station 274. N. B. 73° 46′, Ø. L. 31° 16′. 182 Fvn. (333 M.). 0.0°. Graagrønt Rhabdammina-Ler. Mange Stene (veiende indtil 0.5 Gr.), bestaaende af Sandsten.

Station 275. N. B. 74° 8′, Ø. L. 31° 12′. 147 Fvn. (269 M.). — 0.4°. Grøngraat Rhabdammina-Ler. Mange Stene (veiende indtil 3 Gr.), bestaaende af oxyderet og forvitrende Sandsten, nogle smaa Stykker af Stenkul. I Skraben fandtes: Haard sort Lerskifer, Stenkul, graa Sandsten, Granit, Lerboller, Amfibolit, kornig Kalksten og Kvartsit.

Station 276. N. B. 74° 5′, Ø. L. 27° 39′. 220 Fvn. (402 M.). 0.9°. Graat Ler. Ingen Stene.

Station 277. N. B. 74° 3′, Ø. L. 25° 43′. 225 Fvn. (411 M.). 1.0°. Grøngraat Rhabdammina-Ler. Nogle Stene.

Station 278. N. B. 74° 1′, Ø. L. 22° 27′. 230 Fvn. (421 M.). 0.9°. Grøngraat Rhabdammina-Ler.

Station 279. N. B. 74° 15′, Ø. L. 20° 48′. 79 Fvn. (144 M.). 1.0°. Grøngraat, uensartet Rhabdammina-Ler. Mange Koraller og Skjæl. Nogle Stene (veiende indtil 0.5 Gr.), bestaaende af Kvarts, Sandsten.

Station 280. N. B. 74° 10′, Ø. L. 18° 51′. 35 Fvn. (64 M.). 1.1° Bundprøven bestod hovedsagelig af Muslingskaller med noget grøngraat Ler.

Station 281. N. B. 74° 3′, Ø. L. 17° 18′. 115 Fvn. (210 M.). 2.2°. Brunt Sandler og graat Ler. Nogle Stene (veiende indtil 0.1 Gr.), bestaaende af Kvarts, Sandsten.

Station 282. N. B. 73° 53′, Ø. L. 15° 36′. 457 Fvn. (836 M.). — 0.9°. Grøngraat Ler.

Station 271. — Lat. 72° 38′ N., long. 33° 50′ E.; d. 160 fms. (293 m.); b.-t. 0.7°. A small sample of greenish-grey, homogeneous clay containing numerous Annelids. No pebbles.

Station 272. — Lat. 73° 11′ N., long. 33° 3′ E.; d. 113 fms. (207 m.); b.-t. 1.5°. A greenish-grey Rhabdammina clay on a thin layer of firmer grey clay, containing a few pebbles (the largest weighing 1.0^{gr}) of dark limestone.

Station 273. — Lat. 73° 25′ N., long. 31° 30′ E.; d. 197 fms. (360 m.); b.-t. 2.2°. A greenish-grey clay containing many calcareous shells *(Astarte)* and many exceedingly fine pebbles, chiefly quartz.

Station 274. — Lat. 73° 46′ N., long. 31° 16′ E.; d. 182 fms. (333 m.); b.-t. 0.0°. A greyish-green Rhabdammina clay containing many pebbles (the largest weighing 0.5^{gr}), exclusively sandstone.

Station 275. — Lat. 74° 8′ N., long. 31° 12′ E.; d. 147 fms. (269 m.); b.-t. — 0.4°. A greyish-green Rhabdammina clay containing many pebbles (the largest weighing 3^{gr}) of oxidized and disintegrated sandstone, and a few small fragments of coal. The dredge brought up fragments of a hard, black argillaceous schist, of coal, grey sandstone, granite, amphibolite, granulated limestone, quartzite, and lumps of clay.

Station 276. — Lat. 74° 5′ N., long. 27° 39′ E.; d. 220 fms. (402 m.); b.-t. 0.9°. A grey clay. No pebbles.

Station 277. — Lat. 74° 3′ N., long. 25° 43′ E.; d. 225 fms. (411 m.); b.-t. 1.0°. A greenish-grey clay. No pebbles.

Station 278. — Lat. 74° 1′ N., long. 22° 27′ E.; d. 230 fms. (421 m.); b.-t. 0.9°. A greenish-grey clay.

Station 279. — Lat. 74° 15′ N., long. 20° 48′ E.; 79 fms. (144 m.); b.-t. 1.0°. A greenish-grey clay containing many shells and fragments of coral; likewise a few pebbles (the largest weighing 0.5^{gr}) of quartz, sandstone.

Station 280. — Lat. 74° 10′ N., long. 18° 51′ E.; d. 35 fms. (64 m.); b.-t. 1.1°. This sample consisted chiefly of muscle-shells along with a little greenish-grey clay.

Station 281. — Lat. 74° 3′ N., long. 17° 18′ E.; d. 115 fms. (210 m.); b.-t. 2.2°. A brown, sabulous clay and a grey clay containing a few pebbles (the largest weighing 0.1^{gr}) of quartz, sandstone.

Station 282. — Lat. 73° 53′ N., long. 15° 36′ E.; d. 457 fms. (836 m.); b.-t. — 0.9°. A greenish-grey clay.

Station 283. N. B. 73° 47′, Ø. L. 14° 21′. 767 Fvn. (1403 M.). — 1.4°. Brunt Overgangsler med lidt graat Underler. Ingen Stene.

Station 284. N. B. 73° 1′, Ø. L. 12° 58′. 800 Fvn. (1463 M.). — 1.3°. Brunt Overgangsler med lidt mørkgraat Underler. Ingen Stene.

Station 285. N. B. 73° 6′, Ø. L. 11° 56′. 1024 Fvn. (1873 M.). — 1.3°. Brunt Overgangsler med graat Underler. I det graa Underler to Stene: Sandsten (veiende indtil 4 Gr.).

Station 286. N. B. 72° 57′, Ø. L. 14° 32′. 447 Fvn. (817 M.). — 0.8°. Graat Ler med mange Stene (veiende indtil 2 Gr.), bestaaende af Kvarts, Feldspath, Sandsten. I Skraben fandtes mange tilrundede Stene: Hornblendeskifer, graa Kalksten, Gneisgranit, Gneis, Labradorsten.

Station 287. N. B. 72° 52′, Ø. L. 15° 19′. 249 Fvn. (455 M.). 2.9°. Grønliggraat Ler med lidt brunt Sandler. Mange Stene (veiende indtil 4 Gr.), bestaaende af Sandsten, Granit, Kvartsit.

Station 288. N. B. 72° 46′, Ø. L. 17° 50′. 215 Fvn. (393 M.). 2.4°. Ensartet, brunt Overgangsler med noget graat Underler. Nogle faa Stene (veiende indtil 0.5 Gr.), bestaaende af mørke krystallinske Skifere.

Station 289. N. B. 72° 41′, Ø. L. 20° 18′. 219 Fvn. (400 M.). 2.0°. Grøngraat, haardt Ler. Ingen Stene.

Station 290. N. B. 72° 27′, Ø. L. 20° 51′. 191 Fvn. (349 M.). 3.5°. Ensartet, brunt Sandler med lidt mørkgraat Ler. Faa og ganske smaa Stene (veiende indtil 0.3 Gr.), bestaaende af krystallinske Skifere.

Station 291. N. B. 71° 54′, Ø. L. 21° 57′. 194 Fvn. (355 M.). 3.0°. Graat, sandholdigt Ler. Ingen Stene.

Station 292. N. B. 71° 20′, Ø. L. 22° 59′. 216 Fvn. (395 M.). 3.7°. Brunliggraat Ler. Ingen synlige Foraminiferer.

Station 293. N. B. 71° 7′, Ø. L. 21° 11′. 95 Fvn. (174 M.). 5.1°. Sandholdigt, graat (?) Ler.

Station 294. N. B. 71° 35′, Ø. L. 15° 11′. 637 Fvn. (1165 M.). — 1.2°. Ensartet, brungraat Overgangsler. Ingen Stene. Enkelte Globigeriner. Nogle af Slægten *Lituola*.

Station 283. — Lat. 73° 47′ N., long. 14° 21′ E.; d. 767 fms. (1403 m.); b.-t. — 1.4°. A brown transition clay on a thin layer of grey clay. No pebbles.

Station 284. — Lat. 73° 1′ N., long. 12° 58′ E.; d. 800 fms. (1463 m.); b.-t. — 1.3°. A brown transition clay on a thin layer of dark-grey clay. No pebbles.

Station 285. — Lat. 73° 6′ N., long. 11° 56′ E.; d. 1024 fms. (1873 m.); b.-t. — 1.3°. A brown transition clay on a layer of grey clay, the latter containing two pebbles of sandstone (the largest weighing 4^{gr}).

Station 286. — Lat. 72° 57′ N., long. 14° 32′ E.; d. 447 fms. (817 m.); b.-t. — 0.8°. A grey clay containing many pebbles (the largest weighing 2^{gr}) of quartz, feldspar, sandstone. The dredge brought up numerous pebbles of hornblende schist, grey limestone, gneiss-granite, gneiss, labrador-stone.

Station 287. — Lat. 72° 52′ N., long. 15° 19′ E.; d. 249 fms. (455 m.); b.-t. 2.9°. A greenish-grey clay along with a little brown, sabulous clay containing together many pebbles (the largest weighing 4^{gr}) of sandstone, granite, quartzite.

Station 288. — Lat. 72° 46′ N., long. 17° 50′ E.; d. 215 fms. (393 m.); b.-t. 2.4°. A brown, homogeneous, transition clay on a thin layer of grey clay, containing a few pebbles (the largest weighing 0.5^{gr}) of dark crystalline schists.

Station 289. — Lat. 72° 41′ N., long. 20° 18′ E.; d. 219 fms. (400 m.); b.-t. 2.0°. A hard, greenish-grey clay. No pebbles.

Station 290. — Lat. 72° 27′ N., long. 20° 51′ E.; d. 191 fms. (349 m.); b.-t. 3.5°. A brown, homogeneous, sandy clay along with a little dark-grey clay, containing together a few pebbles (the largest weighing 0.3^{gr}) of crystalline schists.

Station 291. — Lat. 71° 54′ N., long. 21° 57′ E.; d. 194 fms. (355 m.); b.-t. 3.0°. A grey, sabulous clay. No pebbles.

Station 292. — Lat. 71° 20′ N., long. 22° 59′ E.; d. 216 fms. (395 m.); b.-t. 3.7°. A brownish-grey clay, in which no Foraminifera could be detected.

Station 293. — Lat. 71° 7′ N., long. 21° 11′ E.; d. 95 fms. (174 m.); b.-t. 5.1°. Sabulous clay.

Station 294. — Lat. 71° 35′ N., long. 15° 11′ E.; d. 637 fms. (1165 m.); b.-t. — 1.2°. A brownish-grey, homogeneous clay containing a few *Globigerinæ* and *Lituola*. No pebbles.

Station 295. N. B. 71° 59′. Ø. L. 11° 40′. 1110 Fvn. (2030 M.). — 1.3°. Ensartet Biloculinler. Ingen Stene.

Station 296. N. B. 72° 15′. Ø. L. 8° 9′. 1440 Fvn. (2633 M.). — 1.4°. Biloculinler. 5—6 Biloculiner paa hver □-Tomme af den tørrede Bundprøve. Ingen Stene.

Station 297. N. B. 72° 36′. Ø. L. 5° 12′. 1280 Fvn. (2341 M.). — 1.4°. Biloculinler. Faa Foraminiferer. Nogle Stene (veiende indtil 0.8 Gr.), bestaaende af Kvarts, Gneis, Grønsten, Sandsten, Feldspath, Glimmer.

Station 298. N. B. 72° 52′. Ø. L. 1° 51′. 1500 Fvn. (2743 M.). — 1.5°. Ensartet Biloculinler. Omtrent 2 Biloculiner paa hver □-Tomme af den tørrede Bundprøve. Nogle Stene, bestaaende af Kvarts og krystallinske Skifere.

Station 299. N. B. 73° 10′. V. L. 2° 14′. 1366 Fvn. (2498 M.). — 1.6°. Biloculinler. En Sten: Granit.

Station 301. N. B. 74° 1′. V. L. 1° 20′. 1684 Fvn. (3080 M.). — 1.6°. Biloculinler med noget graat underliggende Ler. Nogle Stene (veiende indtil 0.3 Gr.), bestaaende af Kvarts, krystallinske Skifere, Granit. Nogle smaa Fliser af raaddent Træ.

Station 302. N. B. 75° 16′, V. L. 0° 54′. 1985 Fvn. (3630 M.). — 1.7°. En yderst liden Prøve af Biloculinler. En Sten: Lerskifer (veiende 0.5 Gr.).

Station 303. N. B. 75° 12′. Ø. L. 3° 2′. 1200 Fvn. (2195 M.). — 1.6°. Ensartet Biloculinler. 3—4 Biloculiner paa hver □-Tomme af den tørrede Bundprøve. Nogle Stene (veiende indtil 0.3 Gr.), hovedsagelig bestaaende af rød Granit.

Station 304. N. B. 75° 3′. Ø. L. 4° 51′. 1735 Fvn. (3173 M.). — 1.5°. Bundprøven mangler.

Station 305. N. B. 75° 1′. Ø. L. 7° 56′. 1590 Fvn. (2908 M.). — 1.5°. Biloculinler med noget mørkegraat Underler. I Biloculinleret fandtes to Lag — i Lighed med Bundprøven fra Station 245. Nogle Stene: Lerskifere.

Station 306. N. B. 75° 0′. Ø. L. 10° 27′. 1334 Fvn. (2440 M.). — 1.3°. Biloculinler med mange Biloculiner. En Sten: Lerskifer (veiende 1.5 Gr.), omgivet af rødt, stærkt oxyderet Ler.

Station 307. N. B. 74° 58′. Ø. L. 12° 10′. 1216 Fvn. (2224 M.). — 1.4°. Biloculinler.

Station 295. — Lat. 71° 59′ N., long. 11° 40′ E.; d. 1110 fms. (2030 m.); b.-t. — 1.3°. A homogeneous Biloculina clay. No pebbles.

Station 296. — Lat. 72° 15′ N., long. 8° 9′ E.; d. 1440 fms. (2633 m.); b.-t. — 1.4°. Biloculina clay with 5 or 6 *Biloculinæ* to every square inch of the dried sample. No pebbles.

Station 297. — Lat. 72° 36′ N., long. 5° 12′ E.; d. 1280 fms. (2341 m.); b.-t. — 1.4°. Biloculina clay containing a few Foraminifera and divers pebbles (the largest weighing 8gr) of quartz, gneiss, sandstone, feldspar, mica.

Station 298. — Lat. 72° 52′ N., long. 1° 51′ E.; d. 1500 fms. (2743 m.); b.-t. — 1.5°. A homogeneous Biloculina clay with about 2 *Biloculinæ* to every square inch of the dried sample, and containing besides a few pebbles of quartz and crystalline schist.

Station 299. — Lat. 73° 10′ N., long. 2° 14′ W.; d. 1366 fms. (2498 m.); b.-t. — 1.6°. Biloculina clay containing a pebble of granite.

Station 301. — Lat. 74° 1′ N., long. 1° 20′ W.; d. 1684 fms. (3080 m.); b.-t. — 1.6°. Biloculina clay on a thin layer of grey clay, containing a few pebbles (the largest weighing 0.3gr) of quartz, crystalline schist, granite, and a few splinters of rotten wood.

Station 302. — Lat. 75° 16′ N., long. 0° 54′ W.; d. 1985 fms. (3630 m.); b.-t. — 1.7°. A very small sample of Biloculina clay containing a pebble of argillaceous slate (weighing 0.5gr).

Station 303. — Lat. 75° 12′ N., long. 3° 2′ E.; d. 1200 fms. (2195 m.); b.-t. — 1.6°. A homogeneous Biloculina clay with 3 or 4 *Biloculinæ* to every square inch of the dried sample, and containing besides a few pebbles (the largest weighing 0.3gr), chiefly of red granite.

Station 304. — Lat. 75° 3′ N., long. 4° 51′ E.; d. 1735 fms. (3173 m.); b.-t. — 1.5°. No bottom-sample.

Station 305. — Lat. 75° 1′ N., long. 7° 56′ E.; d. 1590 fms. (2908 m.); b.-t. — 1.5°. Biloculina clay on a thin layer of dark-grey clay, containing a few pebbles of argillaceous schist. The Biloculina clay was in two layers, like the sample from Station 245.

Station 306. — Lat. 75° 0′ N., long. 10° 27′ E.; d. 1334 fms. (2440 m.); b.-t. — 1.3°. Biloculina clay containing many *Biloculinæ*, and a pebble of argillaceous schist (weighing 1.5gr) imbedded in red, highly oxidized clay.

Station 307. — Lat. 74° 58′ N., long. 12° 10′ E.; d. 1216 fms. (2224 m.); b.-t. — 1.4°. Biloculina clay.

Station 308. N. B. 74° 57′. Ø. L. 12° 43′. 1136 Fvn. (2078 M.). — 1.3°. Biloculinler med mange Biloculiner, stærkt brunt (oxyderet) paa Overfladen. Ingen Stene. Mange Globigeriner, ligesaa af Slægten *Lituola*.

Station 309. N. B. 74° 57′, Ø. L. 13° 18′. 1065 Fvn. (1948 M.). — 1.3°. To Lag i Bundprøven. Øverst brungult Overgangsler, inderst graablaat Ler.

Station 310. N. B. 74° 56′. Ø. L. 13° 50′. 1006 Fvn. (1840 M.). — 1.4°. En liden Prøve af brunt, ensartet Overgangsler. Faa Biloculiner. Ingen Stene.

Station 311. N. B. 74° 55′. Ø. L. 14° 25′. 898 Fvn. (1642 M.). — 1.3°. Brunt Overgangsler med graat Underler. Ingen Stene.

Station 312. N. B. 74° 54′. Ø. L. 14° 53′. 658 Fvn. (1203 M.). — 1.2°. Graat, mørkt Ler med Spor af brunt Ler. Ingen Stene.

Station 313. N. B. 74° 55′. Ø. L. 15° 49′. 204 Fvn. (373 M.). 2.4°. Graat Ler.

Station 314. N. B. 74° 55′. Ø. L. 15° 21′. 509 Fvn. (931 M.). — 0.6°. Graat Ler med noget brunt Sandler.

Station 315. N. B. 74° 53′. Ø. L. 15° 55′. 180 Fvn. (329 M.). 2.5°. En liden Prøve af graat Ler med noget grønligt Ler (Rhabdamminaler).

Station 316. N. B. 74° 56′. Ø. L. 16° 29′. 129 Fvn. (236 M.). 1.9°. Blaagraat Ler med lidt grønligt Ler. Mange Stene (veiende indtil 3 Gr.), bestaaende af Lerskifere, der ved Optagelsen var meget bløde.

Station 317. N. B. 74° 56′. Ø. L. 16° 52′. 99 Fvn. (181 M.). 2.1°. En liden Prøve af mørkt blaagraat Ler. Ingen Stene.

Station 318. N. B. 74° 56′. Ø. L. 17° 39′. 55 Fvn. (101 M.). 2.1°. En liden Prøve af grøngraat Ler (Rhabdamminaler).

Station 319. N. B. 74° 57′. Ø. L. 18° 22′. 45 Fvn. (82 M.). 2.2°. Stenbund.

Station 320. N. B. 74° 57′. Ø. L. 19° 8′. 31 Fvn. (57 M.). 0.9°. Stenbund.

Station 321. N. B. 74° 56′. Ø. L. 19° 30′. 25 Fvn. (46 M.). 0.2°. Stenbund.

Station 308. — Lat. 74° 57′ N., long. 12° 43′ E.; d. 1136 fms. (2078 m.); b.-t. — 1.3°. Biloculina clay with a dark-brown surface (oxidized), containing many *Globigerinæ* and other Foraminifera of the genus *Lituola*. No pebbles.

Station 309. — Lat. 74° 57′ N., long. 13° 18′ E.; d. 1065 fms. (1948 m.); b.-t. — 1.3°. Two layers, — the upper a brownish-yellow Biloculina clay, the under a greyish-blue clay.

Station 310. — Lat. 74° 56′ N., long. 13° 50′ E.; d. 1006 fms. (1840 m.); b.-t. — 1.4°. A small sample of brown, homogeneous transition clay containing a few *Biloculinæ*. No pebbles.

Station 311. — Lat. 74° 55′ N., long. 14° 25′ E.; d. 898 fms. (1642 m.); b.-t — 1.3°. A brown transition clay on a layer of grey clay. No pebbles.

Station 312. — Lat. 74° 54′ N., long. 14° 53′ E.; d. 658 fms. (1203 m.); b.-t. — 1.2°. A dark-grey clay with traces of a brown clay. No pebbles.

Station 313. — Lat. 74° 55′ N., long. 15° 49′ E.; d. 204 fms. (373 m.); b.-t. 2.4°. A grey clay.

Station 314. — Lat. 74° 55′ N., long. 15° 21′ E.; d. 509 fms. (931 m.); b.-t. — 1.6°. A grey clay along with a little brown, sabulous clay.

Station 315. — Lat. 74° 53′ N., long. 15° 55′ E.; d. 180 fms. (329 m.); b.-t. 2.5°. A small sample of grey clay along with a little greenish clay (Rhabdammina).

Station 316. — Lat. 74° 56′ N., long. 16° 29′ E.; d. 129 fms. (236 m.); b.-t. 1.9°. A bluish-grey clay along with a little greenish clay, containing together many pebbles (the largest weighing 3gr) of argillaceous schist. Previous to drying, the schist was exceedingly soft.

Station 317. — Lat. 74° 56′ N., long. 16° 52′ E.; d. 99 fms. (181 m.); b.-t. 2.1°. A small sample of dark bluish-grey clay. No pebbles.

Station 318. — Lat. 74° 56′ N., long. 17° 39′ E.; d. 55 fms. (101 m.); b.-t. 2.1°. A small sample of greenish-grey clay (Rhabdammina).

Station 319. — Lat. 74° 57′ N., long. 18° 22′ E.; d. 45 fms. (82 m.); b.-t. 2.2°. Bottom stony.

Station 320. — Lat. 74° 57′ N., long. 19° 8′ E.; d. 31 fms. (57 m.); b.-t. 0.9°. Bottom stony.

Station 321. — Lat. 74° 56′ N., long. 19° 30′ E.; d. 25 fms. (46 m.); b.-t. 0.2°. Bottom stony.

Station 322. N. B. 74° 57′, Ø. L. 19° 52′. 21 Fvn. (38 M.). 0.2°. Stenbund.

Station 323. N. B. 72° 53′, Ø. L. 21° 51′. 223 Fvn. (408 M.). 1.5°. Graat Ler.

Station 324. N. B. 73° 47′, Ø. L. 20° 48′. 233 Fvn. (426 M.). 0.9°. Grøngraat Rhabdammina-Ler med blaagraat fastere Underler. Mange Stene (veiende indtil 12 Gr.), bestaaende af Kvarts og Lerskifere.

Station 325. N. B. 74° 2′, Ø. L. 20° 30′. 90 Fvn. (165 M.). 0.9°. Mørkt, grøngraat Ler (Rhabd.-Ler).

Station 326. N. B. 75° 31′, Ø. L. 17° 50′. 123 Fvn. (225 M.). 1.6°. Graagrønt Rhabdammina-Ler. Ingen Stene.

Station 327. N. B. 75° 39′, Ø. L. 16° 33′. 188 Fvn. (344 M.). 0.7°. Ensartet, graat Ler. Ingen Stene.

Station 328. N. B. 75° 42′, Ø. L. 15° 39′. 200 Fvn. (366 M.). — 1.3°. Graat Ler.

Station 329. N. B. 75° 45′, Ø. L. 14° 45′. 199 Fvn. (364 M.). — 0.6°. Mørkt, graat Ler.

Station 330. N. B. 75° 48′, Ø. L. 13° 54′. 444 Fvn. (822 M.). 0.4°. Eiendommeligt, rødligt Ler med noget graat Ler. Ingen Stene.

Station 331. N. B. 75° 51′, Ø. L. 13° 5′. 795 Fvn. (1454 M.). — 1.3°. Rødligt Ler (?).

Station 332. N. B. 75° 56′, Ø. L. 11° 36′. 1149 Fvn. (2101 M.). — 1.5°. Blanding af Biloculinler og noget stærkt oxyderet, rødligt Ler. Faa Stene: Kvarts, Glimmer.

Station 333. N. B. 76° 6′, Ø. L. 13° 10′. 748 Fvn. (1368 M.). — 1.3°. Brunt Overgangsler med nogle enkelte Biloculiner. Ingen Stene.

Station 334. N. B. 76° 12′, Ø. L. 14° 0′. 403 Fvn. (737 M.). 1.0°. Brunt, sandholdigt Overgangsler med mange Kiselspikuler af Svampe. Mange Stene (veiende indtil 2 Gr.), bestaaende af Kvarts og Lerskifer.

Station 335. N. B. 76° 16′, Ø. L. 14° 39′. 179 Fvn. (326 M.). 1.0°. Graagrønt Ler med mange Stene (veiende indtil 4 Gr.), bestaaende af: Kvarts, *Flint*, Sandsten, Lerskifer.

Station 336. N. B. 76° 19′, Ø. L. 15° 42′. 70

Station 322. — Lat. 74° 57′ N., long. 19° 52′ E.; d. 21 fms. (38 m.); b.-t. 0.2°. Bottom stony.

Station 323. — Lat. 72° 53′ N., long. 21° 51′ E.; d. 223 fms. (408 m.); b.-t. 1.5°. A grey clay.

Station 324. — Lat. 73° 47′ N., long. 20° 48′ E.; d. 233 fms. (426 m.); b.-t. 0.9°. A greenish-grey Rhabdammina clay on a layer of firmer, bluish-grey clay containing together many pebbles (the largest weighing 12 gr) of quartz and argillaceous schist

Station 325. — Lat. 74° 2′ N., long. 20° 30′ E.; d. 90 fms. (165 m.); b.-t. 0.9°. A dark greenish-grey clay.

Station 326. — Lat. 75° 31′ N., long. 17° 50′ E.; d. 123 fms. (225 m.); b.-t. 1.6°. A greyish-green Rhabdammina clay. No pebbles.

Station 327. — Lat. 75° 39′ N., long. 16° 33′ E.; d. 188 fms. (344 m.); b.-t. 0.7°. A grey homogeneous clay. No pebbles.

Station 328. — Lat. 75° 42′ N., long. 15° 39′ E.; d. 200 fms. (366 m.); b.-t. – 1.3°. A grey clay.

Station 329. — Lat. 75° 45′ N., long. 14° 45′ E.; d. 199 fms. (364 m.); b.-t. — 0.6°. A dark-grey clay.

Station 330. — Lat. 75° 48′ N., long. 13° 54′ E.; d. 444 fms. (812 m.); b.-t. 0.4°. A peculiar reddish clay along with a little grey clay. No pebbles.

Station 331. — Lat. 75° 51′ N., long. 13° 5′ E.; d. 795 fms. (1454 m.); b.-t. — 1.3°. A reddish clay (?).

Station 332. — Lat. 75° 56′ N., long. 11° 36′ E.; d. 1149 fms. (2101 m.); b.-t. — 1.5°. A mixture of Biloculina clay and a little highly oxidized reddish clay, containing together a few pebbles of quartz, mica.

Station 333. — Lat. 76° 6′ N., long. 13° 10′ E.; d. 748 fms. (1368 m.); b.-t. — 1.3°. A brown transition clay containing a few isolated *Biloculinæ*. No pebbles.

Station 334. — Lat. 76° 12′ N., long. 14° 0′ E.; d. 403 fms. (737 m.); b.-t. 1.0°. A brown, sabulous, transition clay containing many siliceous spicules of sponges and many pebbles (the largest weighing 2 gr) of quartz, argillaceous schist.

Station 335. — Lat. 76° 16′ N., long. 14° 39′ E.; d. 179 fms. (326 m.); b.-t. 1.0°. A greyish-green clay containing many pebbles (the largest weighing 4 gr) of quartz, *flint*, sandstone, argillaceous slate.

Station 336. — Lat. 76° 19′ N., long. 15° 42′ E.;

Fvn. (128 M.). 0.4°. Graat Ler. Mange Stene (veiende indtil 2 Gr.), bestaaende af forvitrende Granit og blød Lerskifer.

Station 337. N. B. 76° 23′, Ø. L. 16° 43′. 20 Fvn. (37 M.). 1.4°. Stenbund.

Station 338. N. B. 76° 19′, Ø. L. 18° 1′. 146 Fvn. (267 M.). — 1.1°. Stenbund.

Station 339. N. B. 76° 30′, Ø. L. 15° 39′. 37 Fvn. (68 M.). 0.9°. Stenbund.

Station 340. N. B. 76° 31′, Ø. L. 14° 40′. 58 Fvn. (106 M.). 0.6°. Graat, uensartet Ler. Mange Stene (veiende indtil 1 Gr.), bestaaende af Kvarts, Kvartsit, Lerskifer. Et lidet Stykke Stenkul.

Station 341. N. B. 76° 32′, Ø. L. 13° 53′. 118 Fvn. (216 M.). 0.8°. Yderst liden Prøve af graat Ler.

Station 342. N. B. 76° 33′, Ø. L. 13° 18′. 523 Fvn. (956 M.). — 1.0°. Brunt Overgangsler med graat Underler. Mange Stene (veiende indtil 3 Gr.), bestaaende af Kvarts og blød Lerskifer.

Station 343. N. B. 76° 34′, Ø. L. 12° 51′. 743 Fvn. (1359 M.). — 1.2°. Brunt Overgangsler med graat Underler. Nogle Stene (veiende indtil 3 Gr.), bestaaende af Kvarts, Glimmerskifer, Lerskifer.

Station 344. N. B. 76° 42′, Ø. L. 11° 16′. 1017 Fvn. (1860 M.). — 1.3°. Brunt Overgangsler. Ingen Globigeriner eller Biloculiner. Nogle faa Stene (veiende indtil 0.5 Gr.).

Station 347. N. B. 76° 40′, Ø. L. 7° 47′. 1429 Fvn. (2613 M.). — 1.3°. Biloculinler.

Station 349. N. B. 76° 30′, Ø. L. 2° 57′. 1487 Fvn. (2719 M.). — 1.5°. Mørkbrunt Biloculinler. Mange Stene (veiende indtil 3 Gr.), bestaaende af mørk Kvarts, krystallinske Skifere, Lerskifer.

Station 350. N. B. 76° 26′, V. L. 0° 29′. 1686 Fvn. (3083 M.). — 1.5°. Biloculinler.

Station 351. N. B. 77° 49′, V. L. 0° 9′. 1640 Fvn. (2999 M.). — 1.5°. Biloculinler.

Station 352. N. B. 77° 56′, Ø. L. 3° 29′. 1686 Fvn. (3083 M.). — 1.5°. Biloculinler. Mange Stene (veiende indtil 1.5 Gr.), bestaaende af Kvarts, Glimmerskifer, Granit, blød Lerskifer.

d. 76 fms. (128 m.); b.-t. 0.4°. A grey clay containing many pebbles (the largest weighing 2^{gr}) of disintegrated granite and soft argillaceous schist.

Station 337. — Lat. 76° 23′ N., long. 16° 43′ E.; d. 20 fms. (37 m.); b.-t. 1.4°. Bottom stony.

Station 338. — Lat. 76° 19′ N., long. 18° 1′ E.; d. 146 fms. (267 m.); b.-t. — 1.1°. Bottom stony.

Station 339. — Lat. 76° 30′ N., long. 15° 39′ E.; d. 37 fms. (68 m.); b.-t. 0.9°. Bottom stony.

Station 340. — Lat. 76° 31′ N., long. 14° 40′ E.; d. 58 fms. (106 m.); b.-t. 0.6°. A grey clay containing many pebbles (the largest weighing 1^{gr}) of quartz, quartzite, argillaceous schist, and a small fragment of coal.

Station 341. — Lat. 76° 32′ N., long. 13° 53′ E.; 118 fms. (216 m.); b.-t. 0.8°. A very small sample of grey clay.

Station 342. — Lat. 76° 33′ N., long. 13° 18′ E.; d. 523 fms. (956 m.); b.-t. — 1.0°. A brown transition clay on a layer of grey clay containing many pebbles (the largest weighing 3^{gr}) of quartz and soft argillaceous schist.

Station 343. — Lat. 76° 34′ N., long. 12° 51′ E.; d. 743 fms. (1359 m.); b.-t. — 1.2°. A brown transition clay on a layer of grey clay containing a few pebbles (the largest weighing 3^{gr}) of quartz, mica, argillaceous schist.

Station 344. — Lat. 76° 42′ N., long. 11° 16′ E.; d. 1017 fms. (1860 m.); b.-t. — 1.3°. A brown transition clay containing a few pebbles (the largest weighing 0.5^{gr}). No *Globigerinæ* or *Biloculinæ*.

Station 347. — Lat. 76° 40′ N., long. 7° 47′ E.; d. 1429 fms. (2613 m.); b.-t. — 1.3°. Biloculina clay.

Station 349. — Lat. 76° 30′ N., long. 2° 57′ E.; d. 1487 fms. (2719 m.); b.-t. — 1.5°. A dark-brown Biloculina clay containing many pebbles (the largest weighing 3^{gr}) of dark quartz, crystalline schist, argillaceous schist.

Station 350. — Lat. 76° 26′ N., long. 0° 29′ W.; d. 1686 fms. (3083 m.); b.-t. — 1.5°. Biloculina clay.

Station 351. — Lat. 77° 49′ N., long. 0° 9′ W.; d. 1640 fms. (2999 m.); b.-t. — 1.5°. Biloculina clay.

Station 352. — Lat. 77° 56′ N., long. 3° 29′ W.; d. 1686 fms. (3083 m.); b.-t. — 1.5°. Biloculina clay containing many pebbles (the largest weighing 1.5^{gr}) of quartz, mica, granite, soft argillaceous clay.

Station 353. N. B. 77° 58′, Ø. L. 5° 10′. 1333 Fvn. (2438 M.). — 1.4°. Biloculinler.

Station 354. N. B. 78° 1′, Ø. L. 6° 54′. 1343 Fvn. (2451 M.). — 1.3°. Biloculinler med graat Underler; det sidste overveiende. I det graa Ler nogle Biloculiner.

Station 355. N. B. 78° 0′, Ø. L. 8° 32′. 948 Fvn. (1734 M.). — 1.3°. Brunt Overgangsler med blaagraat Underler.

Station 356. N. B. 78° 2′, Ø. L. 10° 19′. 110 Fvn. (204 M.). 2.1°. En liden Prøve af graat Ler. Mange Stene (veiende indtil 2 Gr.), bestaaende af Kvarts, *Flint*, Sandsten, Granit.

Station 357. N. B. 78° 3′, Ø. L. 11° 18′. 125 Fvn. (229 M.). 1.9°. Nogenlunde ensartet, finkornigt, graat Ler. Faa Stene (veiende indtil 0.5 Gr.), bestaaende hovedsagelig af Lerskifer.

Station 358. N. B. 78° 2′, Ø. L. 9° 46′. 93 Fvn. (170 M.). 2.6°. En liden Prøve af graat, uensartet Ler. Mange Stene (veiende indtil 8 Gr.), bestaaende af Kvarts, Sandsten, blød og haard Lerskifer.

Station 359. N. B. 78° 2′, Ø. L. 9° 25′. 416 Fvn. (761 M.). 0.8°. Brunt Overgangsler med graasort Underler; det første overveiende. Nogle Stene, bestaaende af Glimmerskifer, Sandsten, Kvarts, Lerskifer, Asbest.

Station 360. N. B. 78° 47′, Ø. L. 6° 58′. 421 Fvn. (770 M.). 0.0°. Stenbund.

Station 361. N. B. 79° 8′, Ø. L. 5° 28′. 905 Fvn. (1655 M.). — 1.2°. Graat Ler. Ingen Stene.

Station 362. N. B. 79° 59′, Ø. L. 5° 40′. 459 Fvn. (839 M.). — 1.0°. Blaagraat Ler.

Station 363. N. B. 80° 0′, Ø. L. 8° 15′. 260 Fvn. (475 M.). 1.1°. Blaagraat Ler.

Station 364. N. B. 79° 48′, Ø. L. 10° 50′. 195 Fvn. (357 M.). 2.3°. Bundprøven bestod hovedsagelig af Skjæl.

Station 365. N. B. 79° 34′, Ø. L. 11° 25′. 74 Fvn. (135 M.). — 1.8°. Mørkgraat Ler.

Station 366. Magdalena Bay. N. B. 79° 35′, Ø. L. 11° 17′. 61 Fvn. (112 M.). — 2.1°. Graat Ler.

Station 367. N. B. 78° 44′, Ø. L. 7° 46′. 535

Station 353. — Lat. 77° 58′ N., long. 5° 10′ W.; d. 1333 fms. (2438 m.); b.-t. — 1.4°. Biloculina clay.

Station 354. — Lat. 78° 1′ N., long. 6° 54′ E.; d. 1343 fms. (2456 m.); b.-t. — 1.3°. Biloculina clay on a layer of grey clay, the latter constituting the greater part of the sample. A few *Biloculinæ* in the grey clay.

Station 355. — Lat. 78° 0′ N., long. 8° 32′ E.; d. 948 fms. (1734 m.); b.-t. — 1.3°. A brown transition clay on a layer of bluish-grey clay.

Station 356. — Lat. 78° 2′ N., long. 10° 19′ E.; d. 110 fms. (201 m.); b.-t. 2.1°. A small sample of grey clay containing many pebbles (the largest weighing 2gr) of quartz, *flint*, sandstone, granite.

Station 357. — Lat. 78° 3′ N., long. 11° 18′ E.; d. 125 fms. (229 m.); b.-t. 1.9°. A fine, grey, comparatively homogeneous clay containing a few pebbles (the largest weighing 0.5gr), chiefly of argillaceous schist.

Station 358. — Lat. 78° 2′ N., long. 9° 46′ E.; d. 93 fms. (170 m.); b.-t. 2.6°. A small sample of grey clay containing many pebbles (the largest weighing 8gr) of quartz, sandstone, soft and hard argillaceous schist.

Station 359. — Lat. 78° 2′ N., long. 9° 25′ E.; d. 416 fms. (761 m.); b.-t. 0.8°. Biloculina clay on a thin layer of greyish-black clay containing a few pebbles of mica schist, sandstone, quartz, argillaceous schist, asbestos.

Station 360. — Lat. 78° 47′ N., long. 6° 58′ E.; d. 421 fms. (770 m.); b.-t. 0.0°. Bottom stony.

Station 361. — Lat. 79° 8′ N., long. 5° 28′ E.; d. 905 fms. (1655 m.); b.-t. — 1.2°. A grey clay. No pebbles.

Station 362. — Lat. 79° 59′ N., long. 5° 40′ E.; d. 459 fms. (839 m.); b.-t. — 1.0°. A bluish-grey clay.

Station 363. — Lat. 80° 0′ N., long. 8° 15′ E.; d. 260 fms. (475 m.); b.-t. 1.1°. A bluish-grey clay.

Station 364. — Lat. 79° 48′ N., long. 10° 50′ E.; d. 195 fms. (357 m.); b.-t. 2.3°. This sample consisted chiefly of calcareous shells.

Station 365. — Lat. 79° 34′ N., long. 11° 25′ E.; d. 74 fms. (135 m.); b.-t. — 1.8°. A dark-grey clay.

Station 366 (Magdalena Bay). — Lat. 79° 35′ N., long. 11° 17′ E.; d. 61 fms. (112 m.); b.-t. — 2.1°. A grey clay.

Station 367. — Lat. 78° 44′ N., long. 7° 46′ E.;

Fvn. (978 M.). — 0.7°. Graat Ler med lidt brunt Sandler. Mange Stene (veiende indtil 0.5 Gr.), bestaaende af krystallinske Skifere.

Station 368. N. B. 78° 43′. Ø. L. 8° 20′. 315 Fvn. (576 M.). 1.6°. Blaagraat, uensartet Ler. En Mængde Stene (veiende indtil 2.5 Gr.), bestaaende af Kvarts, Granit, haard Lerskifer.

Station 369. N. B. 78° 42′. Ø. L. 8° 53′. 87 Fvn. (159 M.). 0.8°. En liden Prøve af graat Ler. En Sten: Sandsten (veiende 8 Gr.).

Station 370. N. B. 78° 48′. Ø. L. 8° 37′. 109 Fvn. (199 M.). 1.1°. Graat Ler. Mange Stene (veiende indtil 3 Gr.), bestaaende af Kvarts, Kvartsit, Sandsten, blød Lerskifer.

Station 371. N. B. 78° 8′. Ø. L. 13° 46′. 197 Fvn. (360 M.). — 0.5°. Graat, fint Ler.

Station 372. N. B. 78° 9′. Ø. L. 14° 7′. 129 Fvn. (236 M.). 1.2°. Mørkgraat Ler.

Station 373. N. B. 78° 10′. Ø. L. 14° 21′. 120 Fvn. (219 M.). 0.8°. Mørkgraat Ler. Nogle Stene (veiende indtil 1 Gr.), bestaaende af krystallinske Skifere.

Station 374. N. B. 78° 16′. Ø. L. 15° 33′. 60 Fvn. (110 M.). 0.7°. Mørkgraat Ler.

Station 375. N. B. 75° 30′. Ø. L. 15° 3′. 204 Fvn. (373 M.). — 0.4°. Isfjorden. Mørkgraat Ler. Ingen Stene.

d. 535 fms. (978 m.); b.-t. — 0.7°. A grey clay along with a little brown, sabulous clay, containing together many pebbles (the largest weighing 0.5^{gr}) of crystalline schists.

Station 368. — Lat. 78° 43′ N., long. 8° 20′ E.; d. 315 fms. (576 m.); b.-t. 1.6°. A bluish-grey clay containing a great many pebbles (the largest weighing 2.5^{gr}) of quartz, granite, hard argillaceous schist.

Station 369. — Lat. 78° 42′ N., long. 8° 53′ E.; d. 87 fms. (159 m.); b.-t. 0.8°. A small sample of grey clay containing a fragment of sandstone, weighing 8^{gr}.

Station 370. — Lat. 78° 48′ N., long. 8° 37′ E.; d. 109 fms. (199 m.); b.-t. 1.1°. A grey clay containing many pebbles (the largest weighing 3^{gr}) of quartz, quartzite, sandstone, soft argillaceous schist.

Station 371. — Lat. 78° 8′ N., long. 13° 46′ E.; d. 197 fms. (360 m.); b.-t. — 0.5°. A fine, grey clay.

Station 372. — Lat. 78° 9′ N., long. 14° 7′ E.; d. 129 fms. (236 m.); b.-t. 1.2°. A dark-grey clay.

Station 373. — Lat. 78° 10′ N., long. 14° 21′ E.; d. 120 fms. (219 m.); b.-t. 0.8°. A dark-grey clay containing a few pebbles (the largest weighing 1^{gr}) of crystalline schists.

Station 374. — Lat. 78° 16′ N., long. 15° 33′ E.; d. 60 fms. (110 m.); b.-t. 0.7°. A dark-grey clay.

Station 375 (Ice Sound). — Lat. 75° 30′ N., long. 15° 3′ E.; d. 204 fms. (373 m.); b.-t. — 0.4°. A dark-grey clay. No pebbles.

Ved nærværende Afhandling er Bundprøverne væsentlig betragtede fra et kemisk Standpunkt. En grundig mikroskopisk Undersøgelse af Slammet med Hensyn til dets forskjellige Bestanddele vilde visselig være af Interesse, men kommer for Øieblikket til at træde i Baggrunden, da jeg endnu ikke har faaet Anledning til at gjøre det nødvendige Forstudium for dette specielle Emne. Men hvis Leilighed dertil gives, kommer jeg maaske senere til at undersøge Expeditionens righoldige Materiale ogsaa i denne Retning. Før der arbeides videre, vil det imidlertid være tjenlig at afvente Resultaterne af Bundprøvernes zoologiske Behandling ved Hr. Professor Sars, ligesom man maa være berettiget til at formode, at Hr. Prof. Mohns Undersøgelser af Havets fysiske Forhold maa kunne kaste Lys over mangt et Spørgsmaal med Hensyn til Slamarternes Udbredelse. Thi vi ved, at mange forskjellige Kræfter kan bidrage til Sedimenternes Dannelse og Afleiring, og for at belyse dem paa en alsidig Maade er det nødvendigt at tage flere af Naturvidenskaberne til Hjælp. Det store Materiale af Bundprøver fra Expeditionens 375 Stationer frembyder rig Anledning til et fortsat Studium. For den kemiske Undersøgelse har de Sedimenter, der forekommer i den fineste og mest ensartede Tilstand, størst Interesse. Jeg har derfor væsentlig lagt Vægten paa det egentlige Dybvandsslam — Biloculinleret —, der desuden ogsaa er det mest ubekjendte. Kystbankernes Afleiringer har jeg derimod taget mindre Hensyn til, da allerede Udseendet viser, at deres kemiske Sammensætning maa være altfor vexlende til, at at det i Almindelighed skulde være Umagen værd at underkaste dem en fuldstændig kemisk Analyse. I mineralogisk Retning har de allerede tidligere været Gjenstand for talrige Undersøgelser.

Rhabdammina-Leret frembyder derimod paa Grund af Forekomststedet og sit særegne Udseende en større Interesse.

For at udføre en fuldstændig kemisk Analyse af Bundprøverne, er jeg gaaet frem paa følgende Maade:

Paa forskjellige Punkter af Bundprøven udtoges nogle Stykker, der pulveriseredes og udvadskedes med Vand for

In this Memoir, the samples of the bottom are regarded chiefly from a chemical point of view. A microscopic examination of the deposit — ooze, mud, or clay — to ascertain the various substances composing it, would unquestionably be attended with interesting results, but cannot, for lack of time and special acquaintance with the subject, be undertaken here. Meanwhile, I may perhaps on some future occasion so investigate the large amount of material collected on the North-Atlantic Expedition. Before proceeding further in that direction, it will however be best to await the results of Professor Sars's zoological treatment of the samples of the bottom, as there is also good reason to believe that Professor Mohn, in his observations to determine the physical conditions of the sea, will throw light on much that is now dubious respecting the distribution of oceanic deposits. We know that divers widely different forces contribute to form the surface-layers of the bottom, and must, therefore, for a full explanation of the phenomena have recourse to several branches of natural science. The rich collection of material obtained on the Norwegian Expedition, at 375 observing-stations, affords ample means for studying the nature of the substances distributed over the bed of the North-Atlantic. As regards the chemical investigation of the samples, it is the finest and comparatively homogeneous deposit that, when submitted to analysis, may be expected to give the most interesting results. Hence, I have laid especial stress upon the necessity of thoroughly investigating the deep-sea or Biloculina clay, — which besides is the least known of oceanic deposits. To the surface-layers of the coastal banks, on the other hand, comparatively little attention has been paid, their outward aspect being of itself sufficient to show that, as a rule, they will not repay the trouble of a rigorous analysis, by reason of the varying character of their constituents. The mineralogical features of these coastal deposits have been repeatedly determined.

Rhabdammina clay has a peculiar and easily recognizable appearance, which gives it accordingly so far exceptional interest.

When submitting the samples of the bottom to rigorous analysis, I went to work as follows: —

Portions of the sample were picked out at different points, pulverized, and washed several times in distilled

at fjerne det vedhængende Søsalt. Ganske fuldstændig sker dette først ved Kogning, men ved Analyserne er forresten en Behandling med koldt Vand tilstrækkelig, da det kun er forsvindende Mængder af Salt, som bliver tilbage i Leret.

Bundprøverne tørredes derpaa ved omtrent 100° C.[1] Nogle Gram udtoges og glødedes i en Platindigel i Perrot's Ovn til konstant Vægt, for at bestemme Vand og organiske Stoffe (Glødningstab). Af den samme Prøve afveiedes 5 eller 10 Gr. — alt efter Lerets Ensartethed — og kogtes i en Kolbe med 80 eller 40 Kc. fortyndet Saltsyre (20 pCt.) i omtrent et Kvarter.

Ved nøiagtig at anvende denne samme Behandlingsmaade ved de forskjellige Analyser faar man nogenlunde overensstemmende Resultater for den dekomponerbare Del af Bundprøven, især ved de finere Slamarter (Biloculinler). Ved nogle Kontrolanalyser, jeg har udført for at forsikre mig om Rigtigheden heraf, har jeg ikke faaet nogen større Variation end 2--3 pCt.

Filtratet fra det saltsure Udtræk fortyndedes til 500 eller 250 Kc. Med en Pipette udtoges af Oplosningen 50 eller 25 Kc., hvori Jern, Lerjord, Kalk og Magnesia bestemtes ved de sædvanlige Fældningsmidler.

En foregaaende Inddampning for at fjerne den opløste Kiselsyre blev tildels udført, men er forøvrigt unødvendig, da denne Bestanddel af Bundprøven kun forekommer sporvis i det saltsure Udtræk.

I en anden Portion bestemtes Jernoxydul ved Titrering med Kamæleon; den samlede Jernmængde fandtes paa samme Vis efter Reduktion med Zink.

Det i Saltsyre uopløste Residuum udkogtes med en Opløsning af kulsurt Natron til Bestemmelsen af Kiselsyren i de dekomponerede Silicater, blev derpaa glødet til konstant Vægt i Perrot's Ovn og veiet. En Del deraf (0.8 til 0.9 Gr.) opsluttedes med kulsurt Kali-Natron, Kiselsyren fraskiltes, og af Filtratet udfældtes Lerjord + Jern og Magnesia paa almindelig Maade. Det første Bundfald opløstes efter Veiningen i koncentreret Saltsyre[2], Jernet bestemtes derpaa ved Fældning med Ammoniak, efterat Lerjorden var fjernet med Natronlud.

For med Hurtighed at kunne bestemme Mængden af

[1] Hvad enten man anvender 100° eller 110°, gjør ingen væsentlig Forskjel.

[2] Ved denne Behandling kan det være vanskeligt at faa Bundfaldet fuldstændig opløst, men dette er heller ikke nødvendigt, da det tilbageblevne uopløste væsentlig bestaar af Lerjord; selv om denne skulde indeholde smaa Mængder af Jern, er den ialfald ved Behandlingen med Saltsyre blevet skikket til at paavirkes af Natronlud, hvorved Jernoxydet bliver uopløst. Dette har jeg ved Forsøg overbevist mig om.

water, to get rid of the salts. This cannot however be done entirely without boiling the mass; but for ordinary chemical analyses, repeated washing in cold water is quite sufficient, the residue of salt still remaining in the substance being hardly appreciable.

The portion of deposit was then dried at about 100° C.[1], after which a few grammes, placed in a platina crucible, were thoroughly heated in one of Perrot's furnaces, to determine the proportion of water and organic substances (loss by ignition). From the same portion, 5 or 10 grammes — according as the deposit was more or less homogeneous in character — were next weighed off and boiled in a flask, for about a quarter of an hour, along with 80^{cc} or 40^{cc} of diluted hydrochloric acid (20 per cent).

By exclusively adopting this method, fairly congruous results may be obtained for the decomposable part of the substance analysed, especially as regards the finer deposits (Biloculina clay). With divers test-analyses specially made to substantiate the trustworthiness of the process in question, the greatest difference did not exceed 2 or 3 per cent.

After dissolving the sediment filtered from the decoction with hydrochloric acid, and diluting the fluid till its volume had reached 500^{cc} or 250^{cc}, the iron, alumina, lime, and magnesia in 50^{cc} or 25^{cc} of the solution — drawn off with a pipette — were determined in the usual manner.

Previous evaporation, to get rid of the silicic acid, was had recourse to for some of the analyses, though such is not strictly necessary, traces only of that constituent occurring in the decoction.

In another portion of the same sample, protoxide of iron was determined by titrating with permanganate of potash, and the total amount of iron in like manner after desoxidation with zinc.

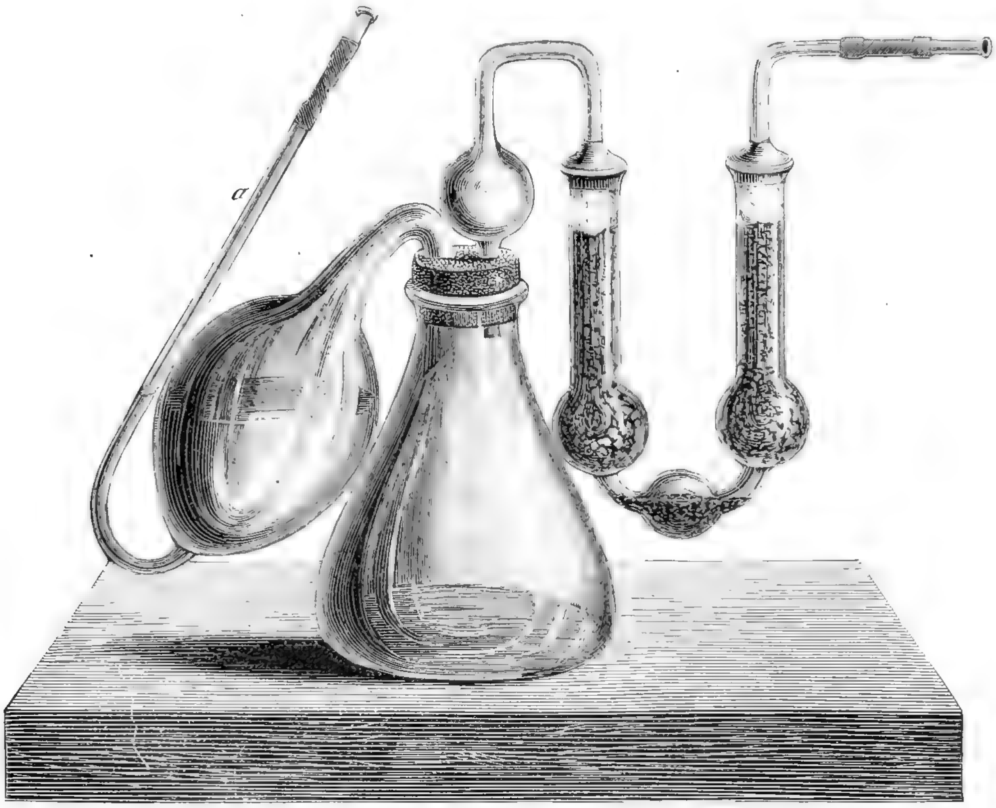
The residue insoluble in hydrochloric acid was boiled along with a solution of carbonate of soda, to determine the proportion of silicic acid present in the decomposed silicates, and was then thoroughly heated in one of Perrot's furnaces, and weighed. Part of it (0.8—0.9 gramme) was fused with carbonate of potash and soda, the silicic acid got rid of, and alumina, iron, and magnesia precipitated in the usual manner. The first deposit was dissolved, after weighing, in concentrated hydrochloric acid,[2] and the iron then present determined by precipitation with ammonia, the alumina having been previously abstracted by means of soda-lye.

To determine in a short space of time the proportion

[1] Whether at 100° or 110° makes very little difference.

[2] Thus treated, it may be difficult to dissolve the whole of the deposit; but this is not necessary, the undissolved residue consisting chiefly of alumina; and even if it should contain minute quantities of iron, the treatment with hydrochloric acid will have rendered it susceptible to the action of soda-lye, causing the oxide of iron to remain undissolved. Of this I have satisfied myself by direct experiment.

den kulsure Kalk i Leret har jeg benyttet et af S. W. Johnson konstrueret Apparat (Zeitschrift für anal. Chemie, 9, S. 90). Dette er fortrinlig skikket til en hurtig og sikker Bestemmelse af Kulsyren i de let dekomponerbare Karbonater. Johnsons Apparat har den Fordel fremfor



Bunsens og de øvrige, at det ikke nødvendiggjør nogen Udsugning og Udkogning for at fjerne den tilbageblevne Kulsyre. Apparatet (se ovenstaaende Tegning) med den afveiede Substans fyldes (gjennem *a*) med tør Kulsyre fra et Udviklingsapparat og veies; derpaa holdes det paaskraa, saa at Saltsyren fra det pæreformige Reservoir rinder over i Kolben. Naar Karbonatet er fuldstændig dekomponeret, ledes Kulsyre atter igjennem og Veiningen udføres paany. Bestemmelsen kræver neppe en halv Time.

Med Apparatet fandt jeg i kulsur Baryt ved to Bestemmelser: 22.27 pCt. og 22.20 pCt.; beregnet: 22.33 pCt.
I Bundpr. fra St. 300 fandtes ligesaa 2.46 pCt. og 2.55 pCt. CO_2
I — „ „ 53 — — 12.70 — 12.81 —
Altsaa en Nøiagtighed som ikke lader noget tilbage at ønske.

of carbonate of lime present in oceanic deposit, I made use of an instrument devised by S. W. Johnson (Zeitschrift für anal. Chemie, 9, S. 90), and admirably adapted for speedy and accurate determination of the carbonic acid in easily decomposable carbonates. Johnson's apparatus has this advantage over Bunsen's and other instruments of the kind, that no absorptive, boiling-out process is necessary to get rid of the residuary carbonic acid. The apparatus in question (see Fig.), containing a given quantity of the substance, is filled (through *a*) with dry carbonic acid, and duly weighed; it is then held obliquely, that the hydrochloric acid from the pyriform reservoir may flow into the flask. So soon as the carbonate of lime is completely decomposed, the carbonic acid is again conducted through the apparatus, and the weighing carried out as before. Half an hour will amply suffice for the operation.

With this apparatus, I found in carbonate of baryta, as the result of two determinations, respectively 22.27 per cent and 22.20 per cent of carbonic acid (by computation 22.33 per cent). Again, in the sample of the bottom brought up at Station 300, the proportion thus determined was 2.46 per cent and 2.55 per cent; in that from Station 53, 12.70 per cent and 12.81 per cent. — a degree of accuracy that leaves nothing to be desired.

Da Farven er et karakteristisk Kjendemærke for den ydre Adskillelse af de forskjellige Sedimenter, maa det være af Interesse at kjende deres dermed sammenhængende kemiske Egenskaber. I denne Anledning maa vi rette vor Opmærksomhed mod den Oxydationsgrad, hvori Lerets Jernmængder befinder sig.

For at faa saa mange Observationer som muligt i denne Retning har jeg samtidig med Kalkbestemmelserne tilberedt mig et saltsurt Udtræk (paa den forud omtalte Maade) af den samme Prøve, hvis Kulsyregehalt var fundet ved Johnsons Apparat. Jernoxydul er titreret med Kamæleon og Jernoxyd med undersvovlsyrligt Natron og Jodopløsning[1].

Som de senere Analyser vil vise, indeholder det saltsure Udtræk den væsentligste Del af Lerets samlede Jernmængde.

Colour being the chief external feature distinguishing oceanic deposits, it must obviously be of interest to learn whence that character is derived; and on investigating the subject, we find chemical agency to constitute the originating cause, — viz. the more or less advanced stage of oxidation in which the iron of the deposit occurs.

With a view to elucidate this question as fully as possible, I prepared, when performing the carbonate of lime determinations, a separate hydrochloric acid decoction (in the manner previously described) of the same sample of deposit in which the proportion of carbonic acid had been found with Johnson's apparatus. The protoxide of iron in this decoction was titrated with permanganate of potash and the sesquioxide with hyposulfite of soda and solution of iodine.[1]

From the subsequent analyses it will appear that the hydrochloric acid decoction contains the greater part of iron present in the deposit.

Graat Ler.

Undersøgelsen af de talrige Bundprøver (over 150), der er indsamlede paa Kystbankerne rundt det europæiske Nordhav, har godtgjort, at den graa (stundom blaagraa) Farve i Almindelighed er en fælles Egenskab for alle de Slamdannelser, der bedækker disse grundere Dele af Havbunden. I andre Retninger er imidlertid dette graa Ler af en temmelig uligeartet Beskaffenhed.

Paa nogle Stationer finder vi det som en fin plastisk Masse, der ved Tørring trækker sig stærkt sammen og danner en haard Klump af en saadan Fasthed, at man ofte maa bruge en Hammer for at slaa den istykker. Andetsteds er Leret mere porøst og grovkornigt; det kryber kun lidet sammen ved Tørring og bliver blot løst sammenhængende.

Denne Uligeartethed er afhængig af Biblandingen af grovere Materiale i Form af Sand (Kvartskorn) og uorganiske Dyrelevninger.

Naar vi underkaster Leret en Slemning for at undersøge dets Blandingsforhold, faar vi et større eller mindre Residuum, der hovedsagelig indeholder Skaller eller Skalbrudstykker af kalkafsondrende Dyr og grovere mineralske Partikler. De sidste bestaar som oftest for en væsentlig Del af smaa Kvartskorn, der i Almindelighed er noget afrundede i Kanterne. I hvilken høi Grad dette uforgjængelige Mineral er fremherskende fremfor de øvrige i Afleiringerne paa de grundere Dele af Havbunden, er paavist af Delesse i hans Værk: „Lithologie du fond des mers."

En paalidelig kvantitativ Slemningsanalyse lader sig vanskelig udføre i de tørrede Bundprøver. Ved Kogning med Vand kan man vistnok faa den faste Lermasse opblødt,

Grey Clays.

A comparative examination of the numerous samples of the bottom (upwards of 150) collected on the coastal banks of the North-Atlantic, has shown that, as a rule, the grey or bluish-grey colour constitutes a distinctive feature common to all sedimentary deposits covering the shallower portions of the sea-bed. In other respects, however, this clay differs very considerably.

At some of the observing-stations it was found to occur as a fine, plastic substance, which, when dried, contracts into a lumpy mass, so hard and compact that a hammer has frequently to be used for breaking it. In other localities, this coastal clay is more porous in character and coarsely granulated; it shrinks very little on exposure to heat, and has, when dry, but trifling cohesive power.

This want of homogeneity arises from the presence of coarser materials, such as sand (quartz) and inorganic animal remains.

On thoroughly washing the clay, to determine the extent of admixture, there will be found a greater or less residue, composed chiefly of calcareous shells or fragments of such and other mineral particles. Grains of quartz, as a rule rounded at the edges, generally constitute the greater part of the latter. The extent to which quartz predominates over other mineral substances as a constituent of oceanic deposit in the shallower parts of the sea-bed, has been shown by Delesse in his work "Lithologie du fond des mers."

To obtain a trustworthy determination of the various mechanical constituents in the clay by washing, is hardly practicable. The concrete substance of the deposit may, indeed,

[1] Den sidste Methode kan vistnok ikke gjøre Fordring paa nogen stor Nøiagtighed, men maa dog ansees for tilfredsstillende ved det foreliggende Øiemed.

[1] Titration by this method does not indeed give a high degree of accuracy, but may for this purpose be regarded as yielding fairly satisfactory results.

men det er neppe muligt at bringe dens amorfe Partikler i en tilstækkelig fint fordelt Tilstand.

Det kunde synes naturligt at antage, at den Grad af Finhed, hvori Lerets mineralske Blandingsdele befinder sig, maatte staa i et lovmæssigt Forhold til Afstanden fra Land. I det store taget er dette ogsaa ganske rigtigt, nemlig naar der er Tale om længere Strækninger, eller hvis man altsaa sammenligner Bundprøver, der er optagne fjernt fra hinanden og paa forskjellige Dyb (f. Ex. paa Kystbankerne og i det egentlige Havbasin), men indenfor det graa Lers eget Omraade er den ovenanførte Regel neppe anvendelig. Kystsedimenternes Foranderlighed og Ubestemthed i denne Retning er tidligere paavist ved talrige Observationer, og Bundprøverne fra den norske Expedition tjener til Bekræftelse herpaa.

Jeg skal saaledes exempelvis nævne, at vi ved Expeditionens sydligste Rute — fra Sognefjordens Munding til Island — paa Stationerne 8 og 9, der ligger 4—5 Mile fra Land, finder en fin ensartet Prøve, der udelukkende bestaar af amorft Ler, medens derimod Stationerne 14 og 18 — omkring 7 og 18 Mile længere ud i Havet — viser et grovkornigt Ler, der ved Slemning gav et betydeligt Residuum (30—40 pCt.) af grovere mineralske Partikler.

Det samme Forhold møder os ved Betragtningen af Bundprøverne fra Expeditionens nordligere Snit. Paa Stationerne 110, 114, 116, 117, 118 og 123 (15—30 Mile fra Land), har jeg saaledes ogsaa fundet fint- og grovkornigt Ler i et vexlende Forhold, der ikke synes at rette sig efter Afstanden fra Kysten. Denne Uregelmæssighed viser sig i det Hele taget overalt paa Kystbankerne, hvor Expeditionen har foretaget Dybdemaalinger fra Land og udover mod Havet i planmæssig Rækkefølge.

Af de Dyr, hvis uorganiske Rester forekommer i Kystleret, gives der naturligvis en Mangfoldighed af Arter, ligesom de ogsaa optræder i vexlende Antal, men sjelden udgjør de nogen væsentlig Del af Bundprøverne. Blandt de almindeligste af de Foraminiferer, der er fundne i Bundprøverne fra de norske Kystbanker, er Slægten *Uvigerina*[1]. Denne Foraminifer er sjeldnere i det graa Ler langs Spidsbergens Kyst, der i det Hele taget synes at være fattigere paa Dyrelevninger. Det kan nævnes, at jeg her paa enkelte Stationer har fundet *Discorbina* i et stort Antal.

Prøverne af graat Ler fra Færø-Islandsbanken viste sig at være næsten fuldkommen frie for Dyrelevninger.

I Havet nordenfor Norge er det vanskelig at bestemme Grændserne for det graa Lers Udbredelse, da det her støder sammen med og lidt efter lidt gaar over i det grønlige Rhabdammina-Ler. Langs Nordkysten af Norge er der af Expeditionen ikke foretaget nogen Dybdemaaling, men vi

[1] Jeg maa oplyse om, at Hr. Prof. Sars har været af den Godhed at bestemme disse i Leret forekommende Dyr, der især deleshed har tiltrukket sig min Opmærksomhed.

be macerated by boiling in water; but how reduce the amorphous matter to the requisite degree of fineness.

It seems reasonable to assume that the magnitude of the mineral constituents of the clay should be mainly determined by the distance from land. And, taken in a broad sense, this is found to be the case, viz. with regard to extensive tracts of the bottom, or, when comparing samples from widely distant localities and different depths (for example, the coastal banks as contrasted with the true ocean-basin); but within the limits of the grey clay formation the rule will hardly apply. The variable and uncertain character of shore-deposits in this respect, has previously been shown by numerous observations, and the samples of the bottom obtained on the Norwegian Expedition afford additional proof.

Thus, for instance, on the most southerly route of the Expedition — from the mouth of the Sognefjord to Iceland — samples of a fine, homogeneous deposit, consisting exclusively of amorphous clayey matter, came up at Stations 8 and 9, distant respectively 4 and 5 geographical miles from land, whereas at Stations 14 and 18, lying about 7 and 18 geographical miles farther out, the bottom was found to be covered with a coarsely granulated clay that, on being thorougly washed, left a very considerable residue (30 or 40 per cent) of coarse mineral particles.

A similar contrast is met with on comparing together the samples of the bottom from the northern section of the tract explored. Thus, at Stations 110, 114, 116, 117, 118, and 123 (from 15 to 30 geographical miles from land), I found finely and coarsely granulated clays occurring under conditions which are in no wise determined, it would seem, by the distance from the coast. This striking want of uniformity proved generally characteristic of coastal deposit wheresoever systematic series of soundings were taken from the shore to the banks.

The inorganic animal remains that occur in the grey coastal clay are referable to a great variety of species, more or less numerously represented, but they rarely constitute any considerable portion of the deposit. Among the Foraminifera found in the samples of the bottom from the Norwegian coastal banks, one of the genera of most frequent occurrence is *Uvigerina*.[1] This animal is comparatively rare in the grey clay off the coast of Spitzbergen, which indeed would appear to be less rich in animal remains. Here, however, at a few Stations, I found the deposit to contain great numbers of the shells of *Discorbina*.

The samples of grey clay from the Færoe-Iceland bank exhibit scarce a trace of animal remains.

In the tract of ocean stretching north of Norway, it is difficult to determine the exact limits for the distribution of the grey clay, since it there borders on, and is gradually merged into, the greenish-coloured Rhabdammina clay. Along the north coast of Norway no soundings were taken, but

[1] Professor G. O. Sars has had the kindness to determine such of the animals occurring in the clay as particularly attracted my attention.

har derimod flere Undersøgelsesstationer i de store Fjorde, der her skjærer sig ind i Landet.

I Altenfjorden fandtes et fint, lyst grøngraat Ler, i Porsangerfjorden et mørkt grønligt, der ligner Rhabdammina-Leret, og i Tanafjorden et ensartet, lysgraat Ler.

Den Del af Østhavets grunde Havbund, der i Syd for Beeren Eiland begynder at skraane ned mod det vestlige Dyb, er vistnok i Almindelighed bedækket af et graat Ler, men dette er ofte biblandet et brunt Sandler, der danner det øverste Lag af Sedimentet og stundom udgjør den overveiende Del af Bundprøven. Disse Uregelmæssigheder har jeg ved Tegningen af Kartet undladt at tage Hensyn til. Som det vil sees af dette, har jeg lagt det graa Ler som en Fortsættelse fra Norges Kystbanker opover mod Nord forbi Vestsiden af Beeren Eiland og videre langs Spidsbergens Kyst. Efter hvad der i det nærmest foregaaende er sagt, vil det imidlertid være indlysende, at de Grændser, jeg har trukket for det graa Lers Udbredelse imellem Norge og Beeren Eiland, er af en noget ubestemt Art eller ialfald maa betragtes med et vist Forbehold. Denne Usikkerhed ved Kartet indskrænker sig imidlertid til denne Del af Havbunden; de øvrige Grændsers Paalidelighed er sikret ved talrigere Stationer og ved en større Grad af Regelmæssighed med Hensyn til Sedimenternes Fordeling.

Det graa Ler langs Spidsbergen synes gjennemgaaende at være af en noget mørkere Farve end Norges Kystler, men hvad der forøvrigt er sagt om det sidste, gjælder i sin Almindelighed ogsaa om hint.

De Bundprøver, der udelukkende bestaar af graat Ler, er sjelden optagne paa nogen større Dybde end 400—450 Favne. Langs den nordlige Del af den norske Kyst findes der blot nogle faa Stationer, som danner Undtagelser fra denne Regel. De mest abnormale i denne Retning er Stationerne 134, 136 og 137[1], hvor vi finder det graa Ler indtil et Dyb af 844 Favne. Ved Betragtning af Dybdekartet over det norske Hav vil man se, at Havbunden, der hvor disse Stationer forekommer, viser en meget eiendommelig Formation. Kystbankerne, der langs Vesteraalen og Lofoten har en temmelig snever Udstrækning, udvider sig nemlig paa dette Sted temmelig pludselig til et større Omraade. Omkring de nævnte Stationer gjør Dybdekurven for 800 Favne en skarp og trang Bugt og fortsættes i en ny Retning, der næsten danner en ret Vinkel med dens foregaaende. Denne eiendommelige og interessante Form af Havbunden er meget nøiagtig bestemt ved talrige Dybdemaalinger. Som det senere skal omtales, fandtes der ogsaa i denne Bugt en Mængde Stene.

Paa de sydligere Dele af de norske Kystbanker synes det graa Ler i Almindelighed at gaa ned til større Dyb end længere Nord. I Øst for Island fandtes det graa Ler

[1] Disse Stationer ligger imellem 67° og 68° N. B. 8° og 9° Ø. L.

the Expedition had several observing-stations in the great fjords of that region.

In the Alten Fjord, the surface-layer of the bottom was found to consist of a fine, light-coloured, greenish-grey clay: in the Porsanger Fjord, of a dark, greenish clay, resembling Rhabdammina; and in the Tana Fjord, of a light-grey homogeneous clay.

The shallow bed of the East Sea, which, south of Beeren Eiland, begins to slope down towards the western depths, is, indeed, in that locality chiefly covered with a grey clay; but a brown, sabulous clay often occurs as the top layer of the deposit, and sometimes constitutes the principal part of the sample. Meanwhile, I had no regard to these exceptional characteristics when drawing the annexed map, in which the grey clay is shown to extend from the Norwegian coastal banks northward past the western shores of Beeren Eiland, and thence along the coast of Spitzbergen. From what has been stated above, it will, however, be apparent, that the limits I have traced for the distribution of the grey clay between Norway and Beeren Eiland are to a certain extent problematical, or should at least be regarded with some reservation. But this uncertainty does not extend to any other part of the sea-bed marked off on the map; numerous observing-stations, together with greater uniformity of distribution, vouch for accuracy as regards the outline of the remaining sections.

The grey clay occurring along the coast of Spitzbergen would appear to be somewhat darker in colour than the Norwegian shore-deposit; but for the rest, what has been observed respecting the latter, will as a rule apply with equal force to the former.

Samples of the bottom consisting exclusively of grey clay were rarely obtained from a greater depth than 400 to 450 fathoms. In some few localities, however, off the northern part of the Norwegian coast, this limit was considerably exceeded. The most notable exceptions to the rule occur at Stations 134, 136, and 137,[1] where the grey clay reaches as far down as 844 fathoms. On examining the Depth Chart, a very peculiar configuration will be seen to characterize the basin of the North Atlantic in the locality where those Stations are located. Here the coastal banks, comparatively narrow off Vesteraalen and Lofoten, suddenly expand. Round the aforesaid Stations, the curve of depth (800 fathoms) makes a sudden bend, after which it strikes off in a new direction well-nigh at right angles to that it had before. This singular and interesting feature in the contour of the ocean-bed has been accurately determined by numerous trustworthy soundings. Here, too, within the bend of the curve, the deposit contained a great many pebbles.

At the southern extremity of the Norwegian coastal banks, the grey clay would as a rule appear to attain a greater depth than at the northern. East of Iceland this

[1] Between lat. 67° N., long. 8° E. and lat. 68° N., long. 9° E.

paa 571 Favne; ligeledes forekom det paa Vestkysten af Spidsbergen i et usædvanligt Dyb (Stationerne 367 og 361, 535—905 Favne).

Som udgjørende en Del af Bundprøverne eller altsaa som det underliggende Lag af Sedimenterne er det graa Ler fundet paa de største Dybder. Dette skal nærmere omtales under Beskrivelsen af de øvrige Slamarter.

Stene fandtes ofte i Bundprøverne, især paa de grundere Steder. Beskrivelsen over deres Art og Udbredelse paa Kystbankerne, saavelsom paa de øvrige Dele af Havbunden, vil jeg gjøre til et særskilt Afsnit af denne Afhandling.

I kemisk Retning frembyder det graa Ler paa Grund af sin Uensartethed eller sit vexlende Blandingsforhold mindre Interesse end de finere Sedimenter. Lerets Kalkgehalt, der nærmest tiltrækker sig vor Opmærksomhed, retter sig naturligvis til en vis Grad efter dets Førraad paa uorganiske Dyrelevninger og udgjør derfor i Almindelighed ingen væsentlig Mængde i Forhold til de øvrige mineralske Bestanddele. Man finder imidlertid ikke sjelden, at Leret i sig selv har en ganske anseelig Kalkgehalt (indtil 20 pCt.), der ikke kan tilskrives de synlige, mekanisk biblandede Rester fra Dyrelivet.

I to forskjellige Bundprøver fra det graa Ler har jeg udført fuldstændige Analyser. Den ene Prøve (362) er fra Expeditionens næstnordligste Station og bestaar blot af graat Ler; den anden (213) er optaget indenfor Biloculinlerets Omraade fra dets underliggende Lag.

Station 362.

N. B. 79° 59′, Ø. L. 5° 40′. 459 Favne (839 Meter). Temperatur ved Bunden — 1.0°. Blaaliggraat, nogenlunde ensartet Ler. Næsten ingen uorganiske Dyrelevninger. Nogle smaa Stene.

	Glødningstab	4.13
Dekomponeret af Saltsyre 24.09 pCt.	Jernoxydul	2.98
	Jernoxyd	2.27
	Lerjord	7.66
	Kalk	0.28
	Magnesia	1.24
	Kulsur Kalk	4.02
	Fosforsyre	Spor
	Kiselsyre	5.64
Udekomponeret af Saltsyre 72.50 pCt.	Jernoxyd	1.51
	Lerjord	9.92
	Magnesia	Spor
	Kiselsyre	61.07
	Sum	100.72

deposit was met with as far down as 571 fathoms; and off the west coast of Spitzbergen it also occurs unusually deep (at Stations 367 and 361, 535—905 fathoms).

As constituting some portion of the samples, viz. their bottom layer, the grey clay has been brought up from the greatest depths. On this head I shall have more to say when describing the other deposits.

Pebbles were frequently found in the samples of the bottom, more especially in those from shallower localities. For investigating the nature of these constituents and their distribution alike on the coastal banks and elsewhere over the bed of the ocean-tract explored, a separate section of this Memoir will be devoted.

As a subject of chemical analysis, the grey clay, by reason of its want of homogeneity, or the extent to which it differs mechanically, is less interesting than the finer of the oceanic deposits. The amount of lime which, from a chemical point of view, chiefly attracts attention, must of course be more or less dependent on the proportion of inorganic animal remains, and from that source, therefore, as a rule, but trifling, as compared with the other mineral constituents. Meanwhile, this clay is not infrequently found to contain a very considerable portion of lime (as much as 20 per cent) which cannot be derived from perceptible calcareous remains of animals mechanically mixed with the deposit.

Of the grey clay, I have submitted two different samples to rigorous analysis. One of these came up at the most northerly Station (362), and consisted exclusively of grey clay; the other was obtained at Station 213, from the under layer of Biloculina clay.

Station 362.

Lat. 79° 59′ N., long. 5° 40′ E.; 459 fathoms (839 metres); bottom-temperature — 1.0°. A bluish-grey, comparatively homogeneous clay containing a few pebbles, but hardly any inorganic animal remains.

	Loss by ignition	4.13
Decomposed by Hydrochloric Acid 24.09 per cent.	Protoxide of iron	2.98
	Sesquioxide of iron	2.27
	Alumina	7.66
	Lime	0.28
	Magnesia	1.24
	Carbonate of lime	4.02
	Phosphoric acid	Traces
	Silica	5.64
Undecomposed by Hydrochloric Acid 72.50 per cent.	Sesquioxide of iron	1.51
	Alumina	9.92
	Magnesia	Traces
	Silica	61.07
		100.72

Samlede Bestanddele:

FeO[1]	Fe_2O_3	Al_2O_3	CaO	MgO	$CaCO_3$	P_2O_5	SiO_2
2.98	3.78	17.58	0.28	1.24	4.02	Spor	66.71

Glødn.tab 4.13 Sum 100.72

Station 213.

N. B. 70° 23', Ø. L. 2° 30'. 1760 Favne (3219 Meter). — 1.2°. Graat, yderst fint Ler, liggende under Biloculinleret, hvoraf der paa denne Station kun fandtes ganske smaa Mængder.

Lerets specifiske Vægt var 2.79.

	Glødningstab	5.59
Dekomponeret af Saltsyre 36.06 pCt.	Jernoxydul	3.06
	Jernoxyd	4.45
	Lerjord	6.32
	Kalk	1.20
	Magnesia	2.76
	Kulsur Kalk	4.27
	Fosforsyre	Spor
	Kiselsyre	14.00
Udekomponeret af Saltsyre 57.20 pCt.	Jernoxyd	2.72
	Lerjord	11.77
	Magnesia	1.59
	Kiselsyre	41.12
	Sum	98.85

Samlede Bestanddele:

FeO	Fe_2O_3	Al_2O_3	CaO	MgO	$CaCO_2$	P_2O_5	SiO_2
3.06	7.17	18.09	1.20	4.35	4.27	Spor	55.12

Glødn.tab 5.59 Sum 98.85

I den følgende Tabel har jeg opstillet de Kalkbestemmelser, der ved Hjælp af Johnsons Apparat er udførte i Prøver fra det graa Ler, tilligemed Mængderne af Jernoxydul og Jernoxyd, som samtidig er fundne ved Titrering i det saltsure Udtræk. I de sidste Rubriker har jeg opført den samlede Jernmængde og Forholdet mellem Oxyderne, hvilket altsaa er et Udtryk for Lerets Oxydationsgrad. For Tabellen er ogsaa medtaget Undersøgelserne af det graa Ler fra nogle af de Stationer, hvor det forekommer som et underliggende Lag indenfor de andre Sedimenters Omraade. Oplysning derom er tilføiet under Anmærkninger.

[1] Jernoxydulmængden refererer sig her — ligesom i de følgende Analyser — blot til den af Saltsyre dekomponerede Del, da den ikke er bestemt i den uopløselige.

Foruden de ovenanførte Bestanddele fandtes i alle Bundprøverne Spor af Mangan i Residuet fra det saltsure Udtræk; dette indeholdt ogsaa i Almindelighed smaa Mængder af Kalk.

Constituents of Sample: —

FeO[1]	Fe_2O_3	Al_2O_3	CaO	MgO	$CaCO_3$	P_2O_5	SiO_2
2.98	3.78	17.58	0.28	1.24	4.02	Traces	66.71

Loss by Ignition. 4.13 = 100.72.

Station 213.

Lat. 70° 23' N., long. 2° 30' E.; 1760 fathoms (3219 metres); bottom-temperature — 1.2°. A grey, exceedingly fine clay underlying the Biloculina clay that occurred very sparingly at this Station.

Specific Gravity of Sample 2.79.

	Loss by ignition	5.59
Decomposed by Hydrochloric acid 36.06 per cent.	Protoxide of iron	3.06
	Sesquioxide of iron	4.45
	Alumina	6.32
	Lime	1.20
	Magnesia	2.76
	Carbonate of lime	4.27
	Phosphoric acid	Traces
	Silica	14.00
Undecomposed by Hydrochloric acid 57.20 per cent.	Sesquioxide of iron	2.72
	Alumina	11.77
	Magnesia	1.59
	Silica	41.12
		98.85

Constituents of Sample: —

FeO	Fe_2O_3	Al_2O_3	CaO	MgO	$CaCO_2$	P_2O_5	SiO_2
3.06	7.17	18.09	1.20	4.35	4.27	Traces	55.12

Loss by Ignition. 5.59 = 98.85.

In the following Table I have given the amount of lime determined with Johnson's apparatus in samples of the grey clay, together with the proportion of protoxide and sequioxide of iron found by titration in the hydrochloric acid solution. The four right hand columns show the total amount of iron and relative proportion of each oxide, thus expressing the degree of oxidation in which the clay occurs. The results set forth in the Table also comprise those obtained on analysing grey clay from some of the localities where it constitutes an under layer of other oceanic deposits. Such samples are specified in the last column, headed "Remarks."

[1] The protoxide of iron refers exclusively, both here and in all subsequent analyses, to the amount decomposed by hydrochloric acid; in that remaining insoluble it was not determined.

Exclusive of the constituents specified above, all the samples of the bottom exhibited traces of manganese in the residue from the hydrochloric acid decoction, which also contained as a rule small quantities of lime.

Station.	Nordlig Bredde. (*N. Lat.*)	Længde fra Greenw. (*Long. f. Greenw.*)	Dybde i engl. Favne. (*Depth in Eng. Fath.*)	$CaCO_3$	Fe_2O_3	FeO	Samlet Fe (*Total Fe.*)	Fe_2O_3 : FeO	Anmærkninger.	(*Remarks.*)
10	61° 41′	3° 19′ E.	220	20.41	3.56	1.59	3.72	2.24	Ingen synlige Kalkskaller.	*No perceptible Calcareous Shells.*
41	63 37	7 10 W.	697	8.13	6.37	3.98	7.56	1.60		
49	65 0	9 25 W.	437	6.50	5.09	3.47	6.26	1.47	Færø—Islands-banken Ingen Kalkskaller.	*The Færoe-Iceland Bank. No Calcareous Shells.*
50	65 26	8 24 W.	571	10.32	4.59	2.19	4.91	2.09		
98	65 56	5 21 E.	388	17.27	2.24	1.90	3.05	1.18	Underliggende Lag (øverst brunt Ler).	*Under Layer; the Upper Brown Clay.*
107	65 21	10 44 E.	172	9.41	2.23	2.02	3.13	1.10	6—7 Mile fra Kysten.	*6 or 7 Miles from the Coast.*
213	70 23	2 30 E.	1760	4.27	4.45	3.06	5.49	1.45	Undrl. Lag (øv. Biloculinler).	*Under Layer; the Upper Biloc. Clay.*
266	71 27	35 39 E.	130	Spor. (*Traces.*)	2.57	2.45	3.71	1.02	Undrl. Lag (øv. Rhabdam.-Ler).	*Under Layer; the Upper Rhabd. Clay.*
289	72 41	20 18 E.	219	3.61	2.56	1.70	3.11	1.51		
301	74 1	1 20 W.	1684	0.45	. .	. .	. .	. .	Underliggende Lag (øverst Biloculinler).	*Under Layer; the Upper Layer Biloculina Clay.*
323	72 53	21 51 E.	223	2.15	3.38	2.28	4.14	1.48		
362	79 59	5 40 E.	459	4.02	2.27	2.98	3.91	0.76		
373	78 10	14 26 E.	120	6.13	2.43	3.00	4.49	0.68	Mørkgraat Ler. Isfjorden.	*Dark-grey Clay. Ice Sound.*

Det vil sees af de ovenanførte Analyser, at Lerets Kalkgehalt er meget variabel, men kun paa et Par Steder opnaar nogen betydeligere Størrelse.

De Tal, der udtrykker Lerets Oxydationsgrad, ligger paa faa Undtagelser nær mellem 1 og 2. Vi kan foreløbig betragte dette som et, med Farven sammenhængende, kemisk Kjendemærke, der kan tjene til at adskille det graa Ler fra de øvrige Sedimenter, hvis Forhold i den samme Retning senere skal belyses.

It will be seen from the above analyses that the proportion of lime varies exceedingly in this clay; but its absolute amount is not considerable save in one or two localities.

The figures expressing the degree of oxidation lie, with but few exceptions, between 1 and 2. This we may regard for the present as a chemical feature intimately connected with colour, that serves to distinguish all grey clays from the other deposits whose similarly derived characteristics I shall elucidate in turn.

Grønligt Ler.

(Rhabdammina-Ler).

Nordhavets østlige Del, der ligger imellem Norge, Beeren Eiland, Spidsbergen og Novaja Semlja, er af en meget ringe Dybde. En Hævning paa lidt over 400 Meter vilde være tilstrækkelig for at løfte dets Bund over Havets Overflade og forvandle den til et stort Sletteland.

De betydelige Strækninger af denne jevne Havbund, der af Expeditionen blev undersøgte, fandtes bedækkede af et Sediment — Rhabdammina-Ler —, som med Hensyn til Udseende og kemisk Beskaffenhed er af en eiendommelig Art. Mest karakteristisk finder vi det paa de østligste Sta-

Green Clays.

(Rhabdammina Clay).

The eastern section of the North Atlantic, between Norway, Beeren Eiland, Spitzbergen, and Novaja Zemlja, is exceedingly shallow. A rise of but little more than 400 metres would suffice to bring the whole of its bed above the surface of the sea and transform the tract into a vast plateau.

In the numerous localities of this extensive region, explored by the Norwegian Expedition, its level floor was found to be covered with a deposit — Rhabdammina clay — peculiar alike in outward appearance and chemical composition. Its characteristic features are most salient in the

tioner (omkring den 38te Længdegrad), hvor det fremtræder som et ensartet, temmelig fint Slam af en eiendommelig mørkgrøn Farve. Efter Tørring opnaar det kun en ubetydelig Fasthed eller Sammenhængskraft og kan mellem Fingrene knuses til et Pulver, der er at føle paa som et meget fint Sand.

Under Mikroskopet viser det sig for en væsentlig Del at bestaa af smaa Kvartskorn, der i Almindelighed er temmelig skarpkantede.

Af Dyrelevninger indeholder Slammet kun faa. Almindeligst finder man Rør af Annelider (udelukkende *Spiochetopterus)*, Kiselspikuler af Svampe og Skaller af Slægten *Astarte*, foruden den omtalte Foraminifer *Rhabdammina*, der synes at være meget almindelig.

Det fremgaar af Bundprøverne fra Expeditionens østligste Stationer, at Rhabdammina-Leret her er af en ringe Mægtighed, da jeg nemlig paa flere Steder har fundet et underliggende Lag af mørkgraat, finkornigt og mindre sandholdigt Ler.

Paa de vestligere Stationer taber Rhabdammina-Leret lidt efter lidt sine karakteristiske Egenskaber; det bliver mere plastisk og Farven mindre udpræget grønlig, ligesom heller ikke nogen Lagdannelse viser sig i Bundprøverne — indtil vi i Syd for Beeren Eiland (under 20—25° Ø. L.) gjenfinder det graa Ler. Nordenom denne Ø gaar Rhabdammina-Leret længere ud i Havet i vestlig Retning og naar her op til Spidsbergens Sydkyst.[1]

I kemisk Retning udmærker det grønlige Ler sig ved sin store Kiselsyremængde og ved den mindre oxyderte Tilstand, hvori det befinder sig. Jeg har troet at iagttage, at flere af Bundprøverne, ved at henligge i Luften (paa Laboratoriet), forandrer sit Udseende, og i en enkelt har jeg ad kemisk Vei konstateret, at den i pulveriseret Tilstand efter nogen Tids Forløb har tiltaget i Jernoxydgehalt, idet Farven samtidig er blevet brunlig. I Bundprøven fra Station 264 fandt jeg nemlig i det saltsure Udtræk ved den første Analyse: 2.48 pCt. FeO og blot 0.24 pCt. Fe_2O_3.[2] et halvt Aar senere erholdt jeg derimod: 1.00 pCt. FeO og 1.39 pCt. Fe_2O_3.

Da jeg har kontrolleret den sidste Bestemmelse og heller ikke har nogen Grund til at tvivle paa Rigtigheden af den første, synes dette mig at være et Fænomen, der er vel værd at lægge Mærke til.

I Rhabdammina-Leret har jeg udført fuldstændige Analyser af to Bundprøver fra Expeditionens østligste Rute,

[1] Rundt om Beeren Eiland vil man paa Kortet finde et aabent Rum. Her har Expeditionen foretaget flere Dybdemaalinger, der viser, at Bunden ikke ligger dybere end 100 Favne. Da Loddet næsten altid stødte mod Sten, blev ingen Bundprøve optaget.

[2] Den samlede Jernmængde er bestemt med Kamæleon efter Reduktion med Zink.

extreme eastern section of the tract (near the 38th parallel of latitude), where this deposit occurs as a homogeneous, comparatively fine mud of a peculiar dark-green colour. Friable when dried, it possesses very little cohesive power, admitting of being crushed between the fingers to powder, which has a gritty feel, like fine sand.

Examined under the microscope, it is minute, and, as a rule, comparatively sharp-edged particles of quartz are found to form its chief constituent.

Of animal remains this deposit contains but few. Those most frequently met with are tubes of Annelids (exclusively *Spiochetopterus)*, siliceous spicules of sponges, and shells of the genus *Astarte*, as also of the previously mentioned Foraminifer *Rhabdammina*, which would appear to be comparatively numerous.

The deposit brought up at the most easterly of the observing-stations shows the surface-layer of Rhabdammina clay in that locality to be of trifling thickness; several of the samples had an under layer of dark-grey, finely granulated, and somewhat sabulous clay.

Throughout the western part of the tract, the Rhabdammina clay gradually loses its distinctive features, becoming more plastic in substance and in colour less characteristically green, with no appearance of stratification in the samples, — till, south of Beeren Eiland (long. 20° to 25° E.) we again meet with the grey clay. North of that island, the Rhabdammina clay extends farther seaward, reaching up to the south coast of Spitzbergen.[1]

Regarded chemically, the chief characteristics of this greenish clay are its large proportion of silica and the slight extent to which it is oxidized. On exposure to atmospheric influence (in the laboratory), several of the samples underwent, I feel pretty sure, a change of aspect; and in one, which had been pulverized and allowed to stand over for some time, I proved by direct analysis an increase in the amount of oxide of iron; its colour, too, had become brownish. Again, in the sample brought up at Station 264, I found in the hydrochloric acid decoction as the result of a first analysis, 2.48 per cent of FeO and only 0.24 per cent of Fe_2O_3;[2] but six months later the proportion determined was 1.00 per cent of FeO and 1.39 per cent of Fe_2O_3.

Having tested the results of the latter analysis and seeing no reason to doubt the accuracy of the first, I call attention to this phenomenon as one that should, I think, by no means pass disregarded.

Of the Rhabdammina clay met with on the eastern route of the Expedition, I have submitted to rigorous ana-

[1] Round the shores of Beeren Eiland a blank space has been left in the map. From several soundings taken here at different points, the depth was found not to exceed 100 fathoms; and the lead having almost invariably struck against rock or stone, no sample of the bottom could of course be obtained.

[2] The total amount of iron was determined with permanganate of potash, after desoxidation with zinc.

nemlig paa den omtalte Station 264 og paa Station 267, hvilke ligger omtrent 15 Mile fra hinanden.

Station 264.

N. B. 70° 56′, Ø. L. 35° 37′. 86 Favne (157 Meter). Temperatur ved Bunden 1.9°. Grøngraat, løst Ler med noget mørkgraat Underler. Talrige Annelider *(Spiochetopterus)*. Ingen Stene.

	Glødningstab	1.85
Dekomponeret af Saltsyre 12.20 pCt.	Jernoxydul	2.48
	Jernoxyd	0.24
	Lerjord	1.72
	Kulsur Kalk	2.54
	Kulsur Magnesia	2.20
	Fosforsyre	Spor
	Kiselsyre	3.02
Udekomponeret af Saltsyre 85.33 pCt.	Jernoxyd	0.12
	Lerjord	1.01
	Magnesia	1.00
	Kiselsyre	83.20
	Sum	99.48

Samlede Bestanddele:

FeO	Fe_2O_3	Al_2O_3	$CaCO_3$	$MgCO_3$	P_2O_5	SiO_2
2.48	0.36	2.73	2.54	2.20	Spor	85.23

Glødn.tab	Sum
1.85	99.48

Den følgende Analyse viser en forholdsvis ringe Forskjellighed fra den første. Bundprøven fra Station 267 er imidlertid optaget paa et større Dyb.

Station 267.

N. B. 71° 42′, Ø. L. 37° 1′. 148 Favne (271 Meter). — 1.4°. Løst, grøngraat Ler med noget mørkgraat Underler. I Bundprøven nogle Stene (veiende indtil 0.5 Gr.), bestaaende af Sandsten og Lerskifer. I Skraben fandtes paa denne Station mange større Stene: haard Skifer, Kvartsskifer, en pibet mørk Sten, Sten med Kisnyre, mørk graa Sandsten, rød Granit, chokoladebrun Tuf (?), mørk Lerskifer.

Lerets spec. Vægt var 2.59.

lysis two different samples, one from the Station previously mentioned, 264, and the other from Station 267, about 15 geographical miles apart.

Station 264.

Lat. 70° 56′ N., long. 35° 37′ E.; 86 fathoms (157 metres); bottom-temperature 1.9°. A greenish-grey, porous clay on a thin layer of dark-grey clay, containing numerous remains of tube-building Annelids *(Spiochetopterus)*; no pebbles.

	Loss by ignition	1.85
Decomposed by Hydrochloric acid 12.20 per cent.	Protoxide of iron	2.48
	Sesquioxide of iron	0.24
	Alumina	1.72
	Carbonate of lime	2.54
	— of magnesia	2.20
	Phosphoric acid	Traces
	Silica	3.02
Undecomposed by Hydrochloric acid 85.33 per cent.	Sesquioxide of iron	0.12
	Alumina	1.01
	Magnesia	1.00
	Silica	83.20
		99.48

Constituents of Sample: —

FeO	Fe_2O_3	Al_2O_3	$CaCO_3$	$MgCO_3$	P_2O_5	SiO_2
2.48	0.36	2.73	2.54	2.20	Traces	85.23

Loss by Ignition
1.85 = 99.48.

Between this and the following analysis there is a slight difference; the sample from Station 267 was however brought up from a greater depth.

Station 267.

Lat. 71° 42′ N., long. 37° 1′ E.; 148 fathoms (271 metres); bottom-temperature — 1.4°. A porous, greenish-grey clay containing a few pebbles (the largest weighing 0.5^{gr}) of sandstone and argillaceous schist. The dredge brought up at this Station numerous stones and pebbles, consisting of hard slate, quartz-schist, dark-grey sandstone, red granite, dark argillaceous schist, also fragments of tuff (?), chocolate-brown in colour, and of a dark fluted stone, as also of a stone containing nodules of pyrites.

Specific gravity of the clay 2.59.

	Glødningstab	5.49
Dekomponeret af Saltsyre 9.83 pCt.	Jernoxydul	2.05
	Jernoxyd	1.00
	Lerjord	0.25
	Kalk	0.20
	Magnesia	1.49
	Kulsur Kalk	0.50
	Fosforsyre	Spor
	Kiselsyre	4.34
Udekomponeret af Saltsyre 83.28 pCt.	Jernoxyd	1.97
	Lerjord	9.33
	Magnesia	1.42
	Kiselsyre	70.56
	Sum	98.60

Samlede Bestanddele:

FeO	Fe_2O_3	Al_2O_3	CaO	MgO	$CaCO_3$	P_2O_5	SiO_2
2.05	2.97	9.58	0.20	2.91	0.50	Spor	74.90

Glødn.tab	Sum
5.49	98.60

Bundprøven fra Station 267 har ikke ligesom den foregaaende undergaaet nogen Forandring ved at henligge i Luften; ved to Bestemmelser af dens Jernoxydul- og Jernoxydmængde med længere Tids Mellemrum er jeg kommet til de samme Resultater. Forholdet mellem Oxyderne var i begge Tilfælde 0.49. At Glødningstabet ved den sidste Bundprøve er betydelig høiere end ved den første, kan maaske være begrundet af en større Rigdom paa organiske Stoffe. Denne er muligens ogsaa forenet med en større Stabilitet ligeoverfor Luftens Paavirkning (?). Begge Bundprøver udviklede ved Ophedning en stærk ammoniakalsk og empyrevmatisk Lugt.

Foruden de ovenanførte Analyser har jeg i Rhabdammina-Leret udført en Del Kalk- og Jernbestemmelser, der vil tjene til Oplysning om dets Dyreliv og eiendommelige Oxydationsforhold. Mængden af den kulsure Kalk er fundet med Johnsons Apparat; Jernoxydul og Jernoxyd bestemt ved Titrering med Kamæleon og undersvovlsyrligt Natron.

Som det vil sees, er Kalkgehalten overordentlig ringe paa alle de Stationer, som ligger østenfor Beeren Eiland og søndenfor denne Ø's Breddegrad. Nogen tilsvarende Fattigdom findes neppe i Nordhavets øvrige Sedimenter eller er ialfald ikke paa saa store Strækninger udbredt med nogen lignende Regelmæssighed. Den samme Mangel paa kulsur Kalk har jeg fundet ved med Saltsyre at forsøge de øvrige Bundprøver, der er indsamlede fra denne Egn af Havbunden. Overalt viser sig kun en ganske ringe Kulsyreudvikling.

Paa Station 326, der ligger i det lille Parti af Rhabdammina-Leret, som paa Kartet er antegnet mellem Beeren

	Loss by ignition	5.49
Decomposed by Hydrochloric acid 9.83 pCt.	Protoxide of iron	2.05
	Sesquioxide of iron	1.00
	Alumina	0.25
	Lime	0.20
	Magnesia	1.49
	Carbonate of lime	0.50
	Phosphoric acid	Traces
	Silica	4.34
Undecomposed by Hydrochloric acid 83.28 pCt.	Sesquioxide of iron	1.97
	Alumina	9.33
	Magnesia	1.42
	Silica	70.56
		98.60

Constituents of Sample: —

FeO	Fe_2O_3	Al_2O_3	CaO	MgO	$CaCO_3$	P_2O_5	SiO_2
2.05	2.97	9.58	0.20	2.91	0.50	Traces	74.90

Loss by Ignition
5.49 = 98.60

Unlike the foregoing, the sample from Station 267 did not undergo any visible or substantial change on being exposed to the air. Two determinations of the protoxide and sesquioxide of iron, performed with a considerable interval between, gave the same results. The ratio of the oxides was in each case 0.49. That the loss by ignition on determining the constituents of the latter sample should have been considerably in excess of that resulting from the analysis of the former, from Station 264, may perhaps be ascribed to a greater abundance of organic remains, which in turn will possibly account for the greater stability exhibited in withstanding the influence of atmospheric air (?). Both samples emitted on exposure to heat a strong ammoniacal and empryeumatic odour.

Exclusive of the above-mentioned analyses, I have performed in Rhabdammina clay divers determinations of lime and iron, which will serve to throw light on the organisms present in that deposit and the characteristic results of its oxidation. The amount of carbonate of lime was found with Johnson's apparatus, that of protoxide and sesquioxide of iron by titration with permanganate of manganese and hyposulfite of soda.

As will be seen from the Table, the proportion of lime was remarkably small in all the samples collected at Stations east and south of Beeren Eiland. A corresponding characteristic as regards this constituent will hardly be found to occur in any other of the North-Atlantic deposits, at least with equal uniformity throughout such extensive tracts. The same comparative absence of carbonate of lime I have determined, by treating with hydrochloric acid, in the remaining samples brought up from that tract of the ocean-bed. The quantity of carbonic acid thus generated was without exception very trifling.

At Station 326, located between Beeren Eiland and Spitzbergen, above the small section of the sea-bed shown

Eiland og Spidsbergen, er Kalkgehalten fundet betydelig høiere end i den sydvestligere Del af Østhavet.

in the map to have a surface-layer of Rhabdammina clay, the sample was found to contain a proportion of lime considerably in excess of that distinguishing the same kind of deposit from the south-western tract of the East Sea.

Station.	Nordlig Bredde. (*N. Latitude.*)	Ø. Længde fra Greenw. (*Long. from Greenw. E.*)	Dybde i engl. Favne. (*Depth in Eng. Fath.*)	$CaCO_3$	Fe_2O_3	FeO	Samlet Fe (*Total Fe.*)	Fe_2O_3 : FeO	Anmærkninger. (*Remarks.*)
264	70° 56′	35° 37′	86	2.54	0.24	2.48	2.09	0.09	
266	71 27	35 39	130	Spor (*Traces.*)	2.57	2.45	3.70	1.02	Underliggende Lag mørkgraat, fast Ler[1]. *On an Under Layer of compact, dark-grey Clay.*[1]
267	71 42	37 1	148	0.50	1.00	2.05	2.29	0.49	
268	71 36	36 18	130	0.48	1.21	1.52	2.03	0.78	
270	72 27	35 1	136	Spor (*Traces.*)	1.51	1.71	2.39	0.88	
275	74 8	31 12	147	1.59	1.32	3.23	3.43	0.41	
326	75 32	17 50	123	16.82	1.19	2.51	2.78	0.47	

Dette er rimeligvis at betragte som en Tilfældighed, da alle de nærliggende Bundprøver (Station 324, 326 og 327) kun bruser svagt for Syrer.

Med Hensyn til det grønlige Lers Oxydationsgrad viser det sig, at det gjennemgaaende indeholder betydelig mere Jernoxydul i Forhold til Oxydet end de graa og de brune Sedimenter. Her maa det tillige bemærkes, at hvor vi ellers i Nordhavet træffer et Ler med lignende Blandingsforhold eller med en tilsvarende høi Kiselsyregehalt, er dette i Almindelighed af en brunlig Farve eller altsaa stærkere oxyderet, men forekommer tillige meget sjelden paa saa ringe Dyb som Rhabdammina-Leret.

Nordhavets østlige Del er imidlertid ogsaa en Egn for sig selv, hvis Særegenheder med Hensyn til Bundens Formationer vanskeliggjør enhver Sammenligning med dets øvrige Partier.

Medens vi langs Norges Vestkyst finder en fra Landet af mere eller mindre jevnt skraanende Havbund, har Østhavet selv paa de fjerneste Punkter omtrent den samme Dybde som lige i Nærheden af Kysterne.

Særegne Betingelser kan saaledes være givne for Sedimenternes og Dyrelivets Fordeling i denne Egn af Havet, hvor Dybderne paa mange Steder — i lang Afstand fra

This, however, is probably a casual occurrence, all the samples collected in adjacent localities (Stat. 324, 326, and 327) effervescing but slightly with acids.

With regard to the degree of oxidation distinguishing Rhabdammina clay, that greenish deposit generally contains much more of the protoxide in proportion to the sesquioxide of iron than do any of the grey or brown clays. Here I must also observe, that wheresoever else on the bed of the North Atlantic we meet with a clay similar in composition, or characterized by an equal amount of silica it will, as a rule, being more highly oxidized, have a brownish colour, but rarely occur at so moderate a depth as Rhabdammina clay.

Meanwhile, the eastern section of the North Atlantic constitutes as regards the nature of the deposits distributed over its bed an exceptional locality, whose phenomenal characteristics well-nigh preclude comparison with the other parts of that ocean tract.

Along the west coast of Norway the bottom shelves more or less gradually from the land, whereas in the East Sea the depth even at the most distant points is almost the same as in close proximity to the shore.

Hence, peculiar conditions may determine the distribution of both sedimentary deposit and animal life in this tract of the ocean, where the depth in numerous localities

[1] Dette gaar altsaa ikke ind under Benævnelsen Rhabdammina-Ler; men er ogsaa optaget i Tabellen paa Side 43 blandt Prøverne af det graa Ler.

[1] This part of the sample, which accordingly is not regarded as Rhabdammina clay, will be found in the Table given on page 43 among the samples of grey clay.

Kysten — ikke er større, end at vi i Overensstemmelse med tidligere Erfaringer kan tænke os, at Bølgernes Virkninger forplanter sig helt ned til Bunden.

I Overensstemmelse med de foregaaende Analyser synes det rimeligt at antage, at Rhabdammina-Leret — saaledes som vi finder det paa de østligste Stationer — maa have sin Oprindelse fra stærkt kvartsholdige Bergarter. For at finde saadanne behøver vi ikke at lede længe i de omgivende Lande; vi møder mægtige Sandstenlag paa Nordkysten af Norge, paa Beeren Eiland og Spidsbergen, ligesom ogsaa talrige Brudstykker af den samme Bergart blev fundne ved de fleste Dybdemaalinger og Skrabninger i Østhavet.

Men selv om vi med nogen Grad af Sandsynlighed kan tænke os, at denne Bergart har været den oprindelige Kilde for Dannelsen af Rhabdammina-Leret, saaledes som vi finder det paa de tvende ovennævnte Stationer, bliver det imidlertid et andet og vanskeligere Spørgsmaal at afgjøre, fra hvilken Kant Materialet er hentet, og hvorledes dette er blevet fordelt over den jevne og grunde Havbund.

Jeg skal her blot indskrænke mig til at nævne, at den omtalte lille Ø Beeren Eiland har særegne Betingelser for at kunne forsyne den nærliggende Havbund med stadig nye Bidrag til dens Afleiringer. Beeren Eiland har allerede i Løbet af en Menneskealder undergaaet betydelige Forandringer ved Isens og Bølgernes ødelæggende Virkninger. De løse itufrosne Bergslag, hvoraf Øen tildels bestaar, ligger ved Kysterne blottede for Havet, hvis Kraft her ikke bliver afdæmpet ved Holmer eller Skjær. Geologen Prof. Keilhau[1] giver i sin Beskrivelse af denne Ø følgende Skildring af, hvorledes Ødelæggelsen foregaar: "Ved saadanne vertikale Revner og ved de ydre Stykkers derpaa følgende Fraløsning gaar Øen lidt efter lidt sin fuldkomne Forsvinden imøde; allerede i Mands Minde er Kysternes Forandring mærkelig, og at slutte efter de ældste Erfaringer, maa allerede betydelige Stykker være undergangne".

Vi maa saaledes være berettigede til at formode, at Beeren Eiland stadig kan give Anledning til sedimentære *Ny*dannelser. Hvis Rhabdammina-Leret kan henregnes blandt saadanne, eller hvis det altsaa er et Depositum af senere Oprindelse end Nordhavets øvrige Sedimenter, kunde dette maaske være en Grund for den mindre oxyderte Tilstand, hvori det befinder sig.

Hvor vi i den vestlige Del af Nordhavet træffer et lignende porøst og stærkt sandholdigt Ler, er dette som oftest af en brun Farve, eller altsaa stærkere oxyderet. Man kunde altsaa tænke sig, at Slammets Oxydationsgrad var afhængig af den Tid, i hvilken det har befundet sig i Havet. Denne Antagelse bestyrkes, naar man ser hen til

[1] Reise til Vest- og Ostfinmarken samt til Beeren Eiland og Spidsbergen.

— at a considerable distance from the coast — is not greater than will, we know, in conformity with experience, admit of the influence of the waves being transmitted from the surface to the bottom.

From the results of the foregoing analyses, it would appear that the origin of Rhabdammina clay, as that deposit occurs in the most easterly localities of the North Atlantic, may be traced to the disintegration of quarzitic rocks, — an assumption borne out by the geological character of the surrounding countries. Along the north coast of Norway, and on Beeren Eiland and Spitzbergen, we meet with vast masses of sandstone; and numerous fragments of that rock came up when sounding and dredging in the East Sea.

But even admitting that disintegrated sandstone has chiefly contributed to the formation of Rhabdammina clay as found at the two above-mentioned Stations, another and more difficult question remains to decide from what quarter the siliceous particles are derived, and how they are distributed over the level and shallow bottom.

On this head I shall merely observe here, that Beeren Eiland has peculiar facilities for constantly furnishing the adjacent portions of the sea-bed with the material composing their surface-layer of deposit. Within the memory of man, the combined action of the waves and glaciers have caused that island to undergo very considerable changes. The porous, frost-riven rocks of which this island in great part consists, are everywhere on the coast exposed to the full sweep of the ocean, no islets or skerries being here to break its force. The following extract from Professor Keilhau's description of Beeren Eiland[1] will show in what manner the work of destruction is proceeding: — "From the repeated occurrence of such vertical fissures and the subsequent dislocation of the outer fragments, the slow but total demolition of the island may be surely foreseen; even within the memory of man, a remarkable change has taken place in the coastal outline, and to judge from the oldest accounts considerable portions of the island must have already disappeared."

We have accordingly every reason to assume, that Beeren Eiland, so long as it exists, will still continue the source of sedimentary *new* formations. Now, regarding Rhabdammina clay as one of such layers, and therefore as of later origin than any other of the deposits distributed over the bed of the North-Atlantic, this may possibly serve to account for the low degree of oxidation by which that substance is distinguished.

A porous and highly sabulous clay is also met with in the western tract of the North Atlantic, but its colour is generally brown, indicating a more advanced stage of oxidation. We might therefore not unreasonably infer that the greater or less extent to which a deposit is oxidized mainly depends on the length of the period during which it has

[1] Reise til Vest- og Ostfinmarken samt til Beeren Eiland og Spitzbergen.

det — rigtignok enestaaende — Tilfælde, i hvilket jeg har paavist en Oxydation af Bundproven ved dens Henliggen i Luften. En saadan Forandring skulde altsaa foregaa med stor Langsomhed i Havet.

Jeg vil imidlertid langtfra paastaa, at den ovenstaaende Forklaring er den rigtige; jeg indrømmer, at den staar paa meget svage Fødder, og har derfor blot fremsat den som en Gisning, for at henlede Opmærksomheden paa Slamarternes eiendommelige Oxydationsforhold. Talrige andre Omstændigheder maa ogsaa tages i Betragtning ved Afgjørelsen af dette Spørgsmaal. Saaledes er det f. Ex. utvivlsomt, at de i Slammet forekommende Dyr bidrager til dets Oxydation. Især finder man ofte en Udskillelse af rødt Jernoxyd paa de Punkter af Leret, hvor Annelider har gravet sig Gange. Mange Foraminiferer virker i den samme Retning, idet de danner sig stærkt jernoxydholdige Skaller. Som forud omtalt er Rhabdammina-Leret meget fattigt paa Dyrelevninger.

En af de Stene, der blev fundne i Østhavet paa Stat. 267, har jeg nærmere undersøgt. Det var en finkornig, blaagraa Sandsten med stærkt kalkholdigt Bindemiddel (Kalksandsten). I det saltsure Udtræk af denne Sten — tilberedt paa samme Maade som i Bundprøverne — fandtes:

1.38 pCt. FeO og 0.59 pCt. Fe_2O_3.

Altsaa et lignende Forhold som i Rhabdammina-Leret.

I Overensstemmelse med hvad der er sagt under Beskrivelsen af det graa Ler, vil det være indlysende, at vi ikke med Nøiagtighed kan bestemme Rhabdammina-Lerets sydlige og vestlige Grændser, da vi mangler de nodvendige Observationer fra denne Del af Havet. Den sidste hollandske Expedition i 1878 har foretaget endel Dybdemaalinger i Retningen Vardø—Beeren Eiland, men Bundens Beskaffenhed er ved denne Anledning ikke blevet nærmere undersogt.

De paa Side 40 omtalte uregelmæssige Afleiringer af brunt Sand og Sandler, der forekommer i Syd og Sydvest for Beeren Eiland, kan maaske ogsaa med Hensyn til sin Dannelse staa i Forbindelse med denne Ø.

Brunt Ler.

(Overgangsler og Biloculinler).

Ved Dybder, der er større end 500 Favne, finder man i Almindelighed Bunden bedækket af et bruntfarvet Sediment. Dette er i Begyndelsen af sin Optræden mindre fint og ensartet (sandholdigt) og af en mere graalig Farve end længere ud i Havet, hvor Biloculinerne forekommer. De Grændser, indenfor hvilke disse Foraminiferer med Regelmæssighed og i større Antal optræder, ligger i Almindelighed et godt Stykke indenfor det brune Lers egentlige Omraade. Den mere eller mindre brede Strimmel af brunt

been lying at the bottom of the sea. Nay, this view will appear still more plausible if we call to mind the case — isolated, it is true — in which I succeeded in determining the oxidation of oceanic deposit after exposure to atmospheric influence. This change in chemical composition must accordingly be very slow on the sea-bed.

Meanwhile, I would by no means venture to imply, that the above explanation is correct: it has weak points, I freely admit, and has therefore been advanced suggestively, with the object of drawing attention to the characteristic results of oxidation in the various deposits. Many other conditions must be taken into account ere this question can be decided. Thus, for instance, the living organisms that occur in the deposit contribute beyond a doubt in some measure to its oxidation. In particular, red oxide of iron is frequently found deposited on the clay where Annelids have excavated their passages; and numerous species of Foraminifera operate with a like result, their shells being rich in oxide of iron. As previously stated, Rhabdammina clay contains very few animal remains.

One of the mineral fragments brought up in the East Sea, at Station 267, I have submitted to analysis. It was a piece of finely granulated, bluish-grey sandstone, with a large admixture of cementitious lime (calcareous sandstone). In the hydrochloric acid decoction of this mineral substance — prepared precisely as was that for analysing the samples of the bottom — I determined: —

1.38 per cent of FeO and 0.59 per cent of Fe_2O_3, accordingly the same proportion as in Rhabdammina clay.

From what has been stated in the description of the green clay, it is obviously impossible to define with accuracy the southern and western limits of the Rhabdammina clay, the necessary observations not having been taken in that part of the North Atlantic. The last Dutch Expedition, however, took a series of soundings between Vardo and Beeren Eiland, but those explorers did not pay any particular attention to the nature of the sea-bed.

The exceptional surface-layers of brown sand and sabulous clay mentioned on page 40, and occurring south and south-west of Beeren Eiland, may possibly as regards their formation be connected with that island.

Brown Clay.

(Transition Clay and Biloculina Clay.)

At depths exceeding 500 fathoms, a brown-coloured clay is generally found to constitute the surface-layer of the bottom. Where it first occurs, this deposit is coarser and less homogeneous in substance (sabulous), and of a greyer shade than farther from the coast, where its chief characteristic consists in the presence of *Biloculinæ*. The limits for the occurrence of these Foraminifera as a constant feature and in greater numbers, reach as a rule a good distance within the true province

Ler, som ikke er noget almindeligt Forekomststed for hine Foraminiferer, eller som altsaa ligger imellem Kystleret og det saakaldte Biloculinler, har jeg paa Kartet afgrændset for sig selv under Navn af Overgangsler.

Det forholder sig imidlertid ikke saaledes, at det graa Ler ophører, hvor det brune begynder at forekomme. Tvertimod finder vi ofte, at det førstnævnte vedbliver at udgjøre det underste Lag af Bundprøven selv indenfor det egentlige Biloculinlers Omraade. Det viser sig saaledes, at det brune Sediment kun meget langsomt tiltager i Mægtighed. Paa flere af Expeditionens Tversnit fandtes det graa Ler som en væsentlig Del af Bundprøven indtil en Afstand af ca. 15 Mile fra den første Station, hvor det brune Ler havde begyndt at vise sig. Et Par af de Bundprøver, der var optagne paa meget store Dyb (over 1700 Favne), bestod udelukkende af graat Ler og indeholdt kun ganske smaa Mængder af det brune. Disse Observationer tyder paa, at Biloculinleret er en Dannelse af ringe Mægtighed, hvilende paa et underliggende Lag af graat Ler. Dette stadfæstes end yderligere ved Skrabningerne, under hvilke en Mængde graat Ler optoges paa de største Dybder.

I Overgangsleret forekommer Biloculiner og de ovrige Dybvands-Foraminiferer blot spredt og enkeltvis. Skjønt det derfor i Almindelighed kun bruser svagt for Syrer, hænder det dog stundom, at Kalkgehalten er temmelig betydelig, selv om ingen Skaller kan iagttages hverken i det oprindelige Ler eller i dets Residuum efter Slemning.

Indenfor de Grændser, hvor de ovennævnte Foraminiferer optræder med Regelmæssighed og i større Antal, er det brune Ler meget fint og ensartet og synes selv under en stærk Lupe kun at bestaa af amorfe Partikler.

Biloculinlerets brune Farve kan være mere eller mindre udpræget. Nogle Bundprøver er lyse gulbrune, andre mørkbrune, i fugtig Tilstand næsten chokoladefarvede. Talrige smaa, hvide Foraminiferer bidrager naturligvis til at give Leret en lysere Farve.

Ved Slemning af Biloculinleret erholder man et større eller mindre Residuum, der væsentlig bestaar af Foraminiferer af forskjellig Størrelse, Form og Farve. Under Lupen viser det sig dog, at nogle yderst smaa, runde Kalkskaller med et tydeligt Kammersystem er langt overveiende i Antal fremfor de øvrige. Professor G. O. Sars har været af den Godhed at bestemme disse Dyr for mig. Han har fundet, at de hører til de meget bekjendte "Globigeriner", men at de er meget mindre udviklede med Hensyn til Størrelse end de, der forekommer i de sydligere Have.

Da disse Dyr overalt i Nordhavet er Biloculinernes uadskillelige Ledsagere, kunde maaske det her omhandlede Sediment ogsaa gaa ind under Navnet "Globigerinler", en Betegnelse, der er blevet benyttet i de britiske Expeditioners Rapporter. Ifølge John Murray skal dette Sediment, hvis mest typiske Eiendommelighed er dets Rigdom paa Globigeriner, forekomme i stor Udstrækning i det af Challenger-expeditionen beseilede Hav, hvor det er fundet paa de fleste

of the brown clay. The strip of brown clay, varying in width, where that deposit does not regularly contain *Biloculinæ*, I have marked off on the map as a separate formation, under the name of transition clay.

Meanwhile, it is by no means to be supposed that the grey clay suddenly terminates where the brown begins to occur. On the contrary, the former deposit was frequently found to constitute the under layer of samples brought up from within the limits of the true biloculina formation. Vertically, therefore, the increase of the brown deposit is very slow. In several of the localities of the tract explored, the grey clay was found to constitute a large part of every sample, within a distance of 15 geographical miles from the first Station at which the brown clay occurred. One or two samples, obtained from great depths (upwards of 1700 fathoms), consisted almost exclusively of grey clay, the admixture of brown deposit being very small. From these data, Biloculina clay is shown to be a deposit of trifling vertical extent, with an underlying layer of grey clay. Moreover, a good deal of grey clay came up in the dredge from the greatest depths.

In the transition clay, *Biloculinæ* and the other deep-sea species of Foraminifera occur but occasionally, and scattered. Hence, though as a rule, therefore, that deposit effervesces very slightly with acids, the proportion of lime is sometimes considerable, even when no calcareous shells can be detected either in the clay itself or the residue left on washing it.

When regularly characterised by the presence of the above-mentioned Foraminifera in considerable numbers, the brown clay is an exceedingly fine and homogeneous deposit, and would appear, even if examined under a powerful magnifier, to consist of amorphous matter.

The brown colour of Biloculina clay varies considerably in depth and distinctness. Some of the samples were light yellowish-brown, others dark-brown, — nay almost of a chocolate shade in a damp state. Numbers of minute white Foraminifera naturally contribute to give the clay a whiter tint.

On washing Biloculina clay, there is a greater or less residue, which chiefly consists of divers species of Foraminifera, varying in magnitude, form, and colour. With the aid of a lens, minute, round, calcareous shells having a distinct system of chambers are found to exceed by far in number the other animal remains. Professor G. O. Sars has had the kindness to determine these animals. He found them to be known *Globigerinæ*, though much less developed in point of size than the species which occur in the Southern Seas.

These animals invariably accompanying *Biloculinæ* in the North Atlantic, the brown deposit here treated of might be also termed "Globigerina clay," a designation adopted in the Reports from the various British Expeditions. According to Mr. John Murray, this sedimentary substance, whose chief typical characteristic consists in the presence of great numbers of *Globigerinæ*, occurs extensively throughout the tracts of ocean investigated on the "Challenger"

Dybder imellem 1000 og 2500 Favne. Hvad der imidlertid ved denne Anledning er blevet kaldt "Globigerina-Ooze", omfatter kun de Slamarter, som for en væsentlig Del bestaar af hine Foraminiferer og altsaa har en meget høi Kalkgehalt. Biloculinleret indeholder derimod paa mange Steder — saaledes som de senere Analyser vil vise — kun en ringe Mængde Kalkskaller i Forhold til sine øvrige mineralske Bestanddele. Lerets Forraad paa Globigeriner differerer nemlig meget i de forskjellige Dele af Nordhavet. Biloculinerne synes derimod at være temmelig jevnt fordelte over Havbunden, men da de i Almindelighed forekommer i ringe Antal (sjelden ser man mere end 2 Biloculiner paa en Kvadratcentimeter af den tørrede Bundprøve) kan de ikke i nogen betydelig Grad bidrage til Lerets Kalkgehalt. Paa Grund af disse Dyrs regelmæssige Forekomst og Udbredelse i Dybvandsslammet synes det mig, at Navnet "Biloculinler" er heldig valgt.

For at kunne gjøre os en Ide om, hvilken Betydning hine Foraminiferer har for Dannelsen af de Afleiringer, i hvilke de forekommer, maa vi tage deres zoologiske Forhold i Betragtning.

Med Hensyn til Globigerinerne er Zoologerne i Uenighed om, hvorvidt de blot er pelagiske Dyr, eller om de ogsaa formaar at leve paa Havbunden[1]. De bekjendte britiske Naturforskere Sir Wyville Thomson, Jeffreys og John Murray er af den Mening, at Globigerinerne blot lever som fritsvømmende Dyr i Havet, og at de først efter sin Død synker tilbunds. Dr. Carpenter forfægter imidlertid en anden Anskuelse, hvori ogsaa Prof. Sars er enig med ham, nemlig at Globigerinerne i sin første Levetid er pelagiske, men tilbringer den sidste Del af sin Tilværelse paa Havbunden.

De øvrige i Slammet forekommende Foraminiferer har man ikke fundet i de øvreliggende Vandlag, og de synes derfor at være henviste til blot at leve paa Bunden. Blandt de almindeligste af disse maa nævnes Slægten *Lituola* med kuglerunde, af Jernfosfat bruntfarvede Skaller, og *Nonionina*, hvis uorganiske Del bestaar af ren kulsur Kalk. Forøvrigt findes der i Leret ogsaa andre Foraminiferer, der danner sine Skaller paa væsentlig mekanisk Vis ved Sammenkitning af Lerets forskjellige Partikler.

Levninger af kiselpantsrede Dyr er ikke synderlig udbredte i Biloculinleret. Under Mikroskopet ser man i de fleste Prøver enkelte smaa fine Spikuler af Svampe, men disse forekommer dog i meget større Maalestok i

[1] Med Hensyn til den zoologiske Literatur om dette Emne kan nævnes følgende Afhandlinger: Dr. Wallich: "The North-Atlantic seabed." Preliminary Report by Dr. Carpenter. (From the Proceedings of the Royal Society No. 107, 1868). "Deep-sea exploration," a lecture by J. Gwyn Jeffreys.

Expedition, having been met with almost everywhere in depths ranging from 1000 to 2500 fathoms. Meanwhile, the surface-layers to which the name of "globigerina ooze" has been given by British naturalists, comprises only such deposits as consist in great part of those Foraminifera and are accordingly distinguished by a very large proportion of lime. Biloculina clay, on the other hand, contains in many localities — as will appear from the results of analyses subsequently given — very few calcareous shells compared to its other mineral constituents. Thus, the number of *Globigerinæ* in this clay from the different parts of the North Atlantic varies considerably, whereas the distribution of Biloculinæ would appear to be comparatively uniform; but these animals occurring as a rule sparingly (more than 2 *Biloculinæ* are seldom observed to a square centimetre of dried deposit), they cannot of course materially contribute to the proportion of lime in the clay. The uniformity of occurrence characterising the distribution of these animals throughout the deep-sea deposit of the North Atlantic, naturally suggested "Biloculina clay" as an appropriate name.

To form a just idea of the extent to which these Foraminifera contribute to the formation of the deposits in which they occur, we must also investigate their zoological conditions.

With regard to *Globigerinæ*, zoologists do not agree, some regarding those Foraminifera as strictly pelagic and others as animals whose habitat is the bed of the sea.[1] The British naturalists Sir Wyville Thomson, J. Gwyn Jeffreys, and John Murray, are of opinion that *Globigerinæ* during life swim freely in the waters of the ocean and when dead sink to the bottom. Dr. Carpenter entertains a different view, shared by Professor G. O. Sars, according to which *Globigerinæ* are pelagic during the early stages of their existence but pass the remainder on the sea-bed.

The other species of Foraminifera present in deep-sea deposit have not been met with in the upper strata of the ocean, and would appear therefore exclusively to inhabit the bottom. Of these animals the genera most numerously represented are *Lituola*, with globular shells, brown in colour from the phosphate of iron they contain, and *Nonionina*, of which the inorganic part consists of pure carbonate of lime. For the rest, North-Atlantic deposit contains divers other Foraminifera, which build up their shells in greater part mechanically, by cementing together minute particles of the clay.

Siliceous remains of animals are not particularly abundant in Biloculina clay. Examined under the microscope, most of the samples were found to contain delicate spicules of sponges, but such constituents occur in far greater num-

[1] The following are some of the chief works in which this subject is treated: — Dr. Wallich: "The North-Atlantic Sea-Bed;" "Preliminary Report by Dr. Carpenter (From the Proceedings of the Royal Society, No. 107, 1868). "Deep-sea Exploration," a Lecture by J. Gwyn Jeffreys.

Overgangsleret, der ofte er saa gjennemvævet af disse fine Kiselnaale, at man ved at berøre den tørrede Bundprøve faar Huden fuld af dem.

Vi er berettigede til at antage, at Havets fysiske Forhold maa have en stor Betydning for Dyrelivets Udbredelse eller Fordeling over Havbunden; især gjælder dette om Globigerinerne, der som pelagiske Foraminiferer maa være udsatte for de forskjellige Strømningers Virkning — hvad enten de nu i død eller levende Tilstand synker ned i Slammet. Ved mine kemiske Undersøgelser af Biloculinleret har jeg, som senere skal sees, taget Hensyn til disse Spørgsmaal.

Betragter man forskjellige Prøver af Biloculinleret under Mikroskopet, vil man finde, at Blandingsdelenes Finhed ikke altid er den samme. Mangensteds kan man neppe selv med en stærk Forstørrelse adskille de enkelte Partikler, men i Almindelighed ser man dog en Del krystallinske Korn, der tildels er af forskjellig Farve. De fleste af disse er imidlertid farveløse og gjennemsigtige og synes for den største Del at bestaa af Kvarts. At dette Mineral kan udgjøre en væsentlig Bestanddel af Dybvandsslammet, har allerede Ehrenberg[1] paavist ved sine Undersøgelser af tre Prøver fra Atlanterhavets Bund (Dybde: 10,800, 12,000 og 12,900 Fod).

Slammets fineste krystallinske Partikler er i Almindelighed temmelig skarpkantede; grovere for det ubevæbnede Øie synlige Korn forekommer næsten aldrig i Biloculinleret, men er derimod ikke ualmindelige i Overgangsleret og har da som oftest en afrundet Form. I det sidstnævnte Ler ser man ofte talrige Glimmerblade; disse forekommer ogsaa i Biloculinleret, men er her saa yderst smaa, at de vanskelig kan opdages.

Pimpsten eller amorft, vulkansk Glas synes ikke at udgjøre nogen væsentlig Del af Biloculinlerets mikroskopiske Bestanddele. I 10–15 Prøver fra forskjellige Partier af Havbunden fandtes vulkansk Glas blot paa et Par Stationer. Nogle større Stykker (2 × 2 × 2 Cm.) blev optagne paa Station 40. Her gjordes forøvrigt et eiendommeligt Fund, der fortjener nærmere Omtale. Sammen med Pimpstenstykkerne fandtes nemlig i Skraben en Mængde faste Klumper eller Knoller, der var af forskjellig Udseende og Art, liggende aldeles for sig selv, ligesom Stene i Lermassen. De største af disse (6 × 6 × 6 Cm.) var af en meget forskjellig og uregelmæssig Form; den haarde og furede Overflade var tildels bedækket af et tyndt sort Lag, der væsentlig var dannet af Manganoxyder, medens det indvendige bestod af en brunrød, porøs Substans, der indeholdt en temmelig betydelig Mængde vulkansk Glas.

Disse Klumper var temmelig faste, men tillige meget sprøde og kunde med Lethed brydes istykker; de havde en

[1] Berliner acad. Berichte von 1854. S. 54. 236. 305. von 1855 S. 173. Nærmere beskrevet i "Microgeologie" von Ehrenberg. Leipzig 1854.

bers in transition clay, which is absolutely interwoven with these minute siliceous needles, so that, on touching the dried bottom-sample, the hand gets covered with them.

We have reason to believe that the physical conditions of the sea exert very considerable influence on the distribution of animal life over its bed; and in particular as regards *Globigerinæ*, which, as pelagic Foraminifera, must be exposed to the action of currents, in whichever state they reach the bottom — living or dead. To these questions, as will afterwards appear, I had due regard when analysing samples of Biloculina clay.

On examining under the microscope Biloculina clay from different localities, the fineness of its constituents is not always found to be the same. In some samples, even when highly magnified, it is hardly possible to distinguish the individual particles of which they consist: a number of crystalline granules, here and there varying in colour, may however be generally detected with a powerful lens; but the majority of such are colourless and translucent, consisting apparently in greater part of quartz, a mineral the occurrence of which as one of the principal constituents of deep-sea surface-layers has been already shown by Ehrenberg,[1] who submitted to analysis three samples of such deposit from the bed of the Atlantic, — depth, respectively 10,800, 12,000, and 12,900 feet.

The finest crystalline particles of deep-sea deposit are as a rule comparatively sharp-edged; coarser granules occur very rarely if ever in Biloculina clay, whereas in transition clay such particles, of a rounded form, are not infrequently met with. The latter deposit is often found to contain numerous laminæ of mica schist, which also occur in Biloculina clay, but so delicate and minute as to be with difficulty detected.

Pumice or scoriæ does not appear to be one of the chief microscopic constituents of Biloculina clay. Of 10 to 15 samples from different parts of the sea-bed, scoriæ occurred in one or two only. A few larger pieces (2 × 2 × 2^{cm}) came up at Station 40, where the deposit was found to be characterized by a peculiar feature, which I must not omit to record. Along with the fragments of pumice, but lying apart and imbedded like stones or pebbles in the clay, the dredge brought up a number of nodules or concretions, varying in character and appearance. The largest, measuring 6 × 6 × 6^{cm}, were very different and irregular in form; the hard, furrowed surface had in some a thin coating of black oxide of manganese, whereas the inner portion consisted of a brownish-red, vesicular substance, containing a considerable proportion of scoriæ.

These concretions are comparatively firm, but at the same time exceedingly brittle; their weight too is very

[1] Berliner acad. Berichte von 1854, pp. 54, 236, 305, von 1855 p. 173. The subject is treated more at large in "Microgeologie" von Ehrenberg. Leipzig 1854.

meget ubetydelig Vægt og flød (i tørret Tilstand) paa Vand ligesom Pimpsten.

Den indvendige røde Substans var at føle paa som meget fint Mel og smuldrede let hen ved Berøring. Den havde følgende Sammensætning:

Glødningstab	14.46
Jernoxyd	26.15
Lerjord	14.14
Magnesia	1.38
Kiselsyre	40.45
Sum	96.58[1]

Paa Grund af sin ujevne Form og ubetydelige Vægt havde disse Klumper ved det første Øiekast megen Lighed med Pimpstene, men den nærmere Undersøgelse viste dog, at de forøvrigt var meget forskjellige fra disse. Intet sammenhængende Kiselskelet kunde paavises, og hvad der ved første Blik kunde antages for Blærerum, befandtes ved Eftersyn kun at være Huller efter Annelider, der isærdeleshed paa Overfladen havde gravet sig talrige Gange. Den indre røde Substans bestod vistnok for en Del af amorft, vulkansk Glas, men dette forekom i friske Splinter eller Stykker af et lignende Udseende, som det af Vulkanerne udkastede Pimpstenspulver.

Jeg er dog tilbøielig til indtil videre at fastholde den Tanke, at disse Klumper kan have sin Oprindelse fra Pimpstene, der har gjennemgaaet betydelige Forandringer paa Havbunden, hvor de har virket som et Filtrum for det gjennemstrømmende Vand. Det kan muligens tjene til Oplysning om denne Vandets Bevægelse paa Havbunden, at alle Furer eller Revner i de ovennævnte Klumper var delvis fyldte med Skaller af Globigeriner.

Paa Stat. 40 fandtes som sagt ogsaa en Del Stykker af umiskjendelig Pimpsten, der imidlertid var af en meget løs og usammenhængende Konsistens.

Foruden de ovenomtalte Klumper optoges paa samme Sted ogsaa andre, der var mindre end hine og forøvrigt af et ganske forskjelligt Udseende. Nogle af disse bestod af en hvid Substans, der havde megen Lighed med Kaolin. En mikroskopisk Undersøgelse viste, at den indeholdt en Mængde Kiselskaller af Diatomeer. Andre havde Form af flade Stykker og bestod af et mørkgrønt, fint Ler med enkelte gulhvide Baand. Den fjerde og sidste Slags var dannet af en fin og fast, gulhvid Substans, der i Udseende nærmest kunde sammenlignes med haard, hvid Ost. I de to sidstnævnte Arter opdagede jeg under Mikroskopet nogle enkelte Diatomeer og blot faa Splinter af vulkansk Glas.

Det synes altsaa, som om vi her paa en af Expeditionens sydligste Stationer har fundet Dannelser af lignende Art som de, der omtales af John Murray i "Reports from the Challenger".

[1] Da denne røde Substans ogsaa indeholdt noget Mangan, der ikke blev bestemt, kan maaske Tabet ved Analysen hidrøre derfra.

trifling, and they float (in a dry state) on the surface of water, like pumice.

The red inner substance, which crumbled to the touch, became impalpable as the finest flour on being reduced to powder. Its chemical constituents were as follows: —

Loss by ignition . .	14.46
Oxide of iron . . .	26.15
Alumina	14.14
Magnesia	1.38
Silicic acid	40.45
	96.58[1]

By reason of their irregular form and inconsiderable weight, these concretions had apparently much in common with pumice; but a closer examination showed them to be essentially different from that substance. No siliceous skeleton could be detected, and what at the first glance might have been taken for vesicular cavities, proved to be the work of Annelids, which, from the surface in particular, had excavated many of their passages. The red-coloured inner substance did not indeed partly consist of scoriæ, but this constituent occurred in the form of minute splinters or particles, similar in appearance to the pumice-powder ejected by volcanoes.

Meanwhile, I am most inclined to regard these concretions, till further light shall have been thrown on their phenomenal occurrence, as the product of pumice, which, from having acted as a percolating medium for water flowing over the sea-bed, has undergone partial transformation. As a feature in some measure perhaps explanatory of the conditions determining the motion of such water, I can add that all furrows and crevices in the said concretions contained shells of *Globigerinæ*.

At Station 40, as previously stated, the dredge brought up a few pieces of unmistakeable pumice, exceedingly porous however and friable.

Exclusive of the above-described concretions, others of a smaller size and widely different appearance came up in the same locality. Some of these consisted of a white substance presenting considerable resemblance to kaolin, which, on being examined under the microscope, was found to contain great numbers of the siliceous shells of Diatoms. Others were lamellar in form, and consisted of a fine dark-green clay marked with a few yellowish-white bands. A fourth kind — the last — were formed of a fine and firm yellowish-white substance, in appearance very like hard, white cheese. The two last-mentioned kinds of concretions exhibited under the microscope divers isolated shells of Diatoms and a very few splinters of scoriæ.

Hence it would appear that the Norwegian Expedition, at one of its most southerly observing-stations, met with formations similar to those described by Mr. John Murray in "Reports from the 'Challenger'."

[1] The red-coloured part of the concretions having also contained manganese, this constituent is possibly comprised in the loss resulting from the analysis.

Ved denne Expedition optoges nemlig fra Havbunden en Mængde Klumper og Knoller, hvoraf enkelte ifølge Beskrivelsen maa være af en lignende Art som de ovennævnte fra Station 40. Den betydelige Udfældning af Manganoxyder, der ved samme Anledning blev paavist i Havbundens Afleiringer, synes derimod ikke at have noget Sidestykke i det europæiske Nordhav.

Jeg har forud omtalt, at det brune Ler kun synes at udgjøre et tyndt Lag paa Havbunden. Hvor denne begynder at skraane op mod Kystbankerne og nærme sig til det graa Lers Territorium, finder vi i Særdeleshed ofte i Bundprøven et underliggende Lag af det sidstnævnte Sediment. Nedover mod Dybet tiltager det brune Ler i Mægtighed, og indenfor Biloculinlerets Omraade finder vi de fleste Bundprøver helt igjennem ensartede. De enkelte Steder, hvor der ogsaa her findes tvende forskjellige Lag i Bundprøven og den Mængde af graat Ler, der optoges med Skraben eller Trawlen, viser at Biloculinleret er af en forskjellig, men i det Hele taget ringe Tykkelse. Paa den Del af Havbunden, der ligger omkring Stationerne 213, 214 og 215 paa et Dyb af over 1700 Favne synes Biloculinleret i Særdeleshed at være meget tyndt udbredt. Paa Stat. 215 udgjorde det graa Ler den overveiende Del af Bundprøven og paa Stat. 213 fandtes kun Spor af Biloculinler. Dette graa Underler er meget fint, ensartet og plastisk, og bliver efter Tørring meget fast og sammenhængende. Leret indeholder ingen Dyrelevninger og Kalkgehalten er kun ubetydelig. Under Mikroskopet viser det yderst smaa krystallinske Partikler (Kvarts?), der først træder tydelig frem ved en Forstørrelse af 500—600 Gange.

De Bundprøver, der blot bestaar af Biloculinler, er i Almindelighed helt igjennem ensartede med Hensyn til Udseende og Foraminiferernes Skaller saa jevnt fordelte i Lermassen, at ethvert Stykke af denne omtrent viser den samme Kalkgehalt.

Paa enkelte Steder forekommer dog i selve Biloculinleret en Lagdannelse, der giver sig tilkjende derved, at Bundprøvens øverste Del bestaar af et brunt, fint Ler uden Kalkskaller, medens der under dette findes et porøst Ler med en Mængde Foraminiferer. Denne Lagdannelse er af en lignende Art som den, man erholder ved at slemme Biloculinleret ud i Vand og derpaa lade det afsætte sig. Ved denne Operation synker alle Kalkskaller tilligemed andre grovere Partikler tilbunds, medens man øverst faar et fint kalkfattigt Ler. Det synes rimeligt at antage, at en lignende Bundfælding allerede kan foregaa i Havet og bidrage til den ovenomtalte Lagdannelse, men i saa Fald maa man fristes til at spørge, hvorfor den ikke altid forekommer i Biloculinleret.

Vi mangler for Øieblikket Forudsætninger til at kunne besvare dette Spørgsmaal, thi hertil kræves Kundskab om

On that British Expedition numerous nodules and concretions were brought up in divers localities from the bed of the sea, some of which, to judge from the description, must have been similar in character to those that came up on the Norwegian Expedition at Stat. 40. Meanwhile, the very considerable proportion of oxide of manganese determined as a constituent of the deposit in which the nodules lay imbedded, does not appear to accompany the occurrence of such concretions in the North Atlantic.

As previously stated, the brown clay would appear to constitute a comparatively thin surface-layer. Where the sea-bed, shelving up to the coastal banks, begins to approach the province of the grey clay, samples of the bottom have very frequently an under layer of that deposit. Downward, in the direction of the depths, the brown clay increases in vertical extent, and within the limits of Biloculina clay, most samples of the bottom are found to be homogeneous throughout. From the few samples which even here consisted of two different layers, together with the large quantity of grey clay brought up in the dredge or trawl, Biloculina clay is however clearly shown to be a deposit of trifling though variable extent in a vertical direction. Throughout the section of the sea-bed surrounding Stations 213, 214, and 215, at a depth of more than 1700 fathoms, Biloculina clay would in particular appear to be very thinly distributed. At Station 215, the sample consisted in greater part of grey clay, and in that brought up at Station 213, traces only of Biloculina clay were observed. This grey underlying clay is fine, homogeneous, and plastic, and becomes on being dried exceedingly firm and cohesive; it contains no animal remains and the amount of carbonate of lime is inconsiderable (1—2 per cent). With the aid of the microscope, minute crystalline particles (possibly quartz), may be detected, which do not become distinctly visible till magnified five or six hundred times.

Samples of the bottom consisting exclusively of Biloculina clay, are as a rule uniform in appearance throughout, and the foraminiferous shells so regularly distributed in the deposit, that every part of it has well-nigh the same proportion of lime.

In certain localities, however, the surface-layer of Biloculina clay was found to be exceptional in formation: a fine brown clay without calcareous shells constituted the upper part of the sample, whereas the under layer consisted of a porous clay containing great numbers of Foraminifera. This formation is similar to that of the deposit left on washing Biloculina clay, during which operation the calcareous shells and other coarser particles sink to the bottom, leaving a fine clay, containing very little lime, as the upper layer. Some such precipitating process may not improbably be going on in the waters of the ocean and thus contribute to the formation described above; but if so, the question naturally arises why the latter is not an invariable characteristic of Biloculina clay.

For the full investigation of this subject we are at present in want of the requisite data, assuming as it does

forskjellige Forhold, der endnu er os fuldkommen ubekjendte. Vi har saaledes ingen Erfaring om de kvantitative og temporære Betingelser, der er givne for Globigerinernes Afleiring paa Havbunden. Lige saa lidt kan vi af de i Bundprøverne fundne Skaller af ikke-pelagiske Foraminiferer slutte os til, hvor stærkt de levende Dyr har været repræsenterede i Slammet, eller hvorlænge de døde Dyrs Skaller vil opbevares paa Havbunden — tvende Spørgsmaal, der vel maa have sin Betydning for Slammets mekaniske Afleiring. Det er dog rimeligt at antage, at lang Tid kræves, for at Søvandet skal kunne opløse disse Kalkskaller. Vi ved af tidligere Forsøg, at de paa Grund af sin Gehalt paa organiske Stoffe ikke forholder sig som ren kulsur Kalk ligeoverfor Oplosningsmidler, men at de angribes langt vanskeligere. Man har fremsat den Paastand, at den kulsure Kalk lettere opløses i Dybet paa Grund af den større Mængde Kulsyre, som her skulde findes i Søvandet. Hr. Tornøes Undersøgelser over Kulsyremængden i det af den norske Expedition beseilede Hav modbeviser imidlertid denne Antagelse. Han har fundet, at Søvandet overalt reagerer alkalisk og altsaa ikke kan indeholde nogen fri, men blot normalt- og surtbunden Kulsyre; Mængden af denne er imidlertid paa Dybet omtrent den samme som ved Overfladen. At Forholdet skulde være anderledes i de øvrige Dele af Oceanet synes ikke at have nogen Sandsynlighed for sig, naar man ser hen til de talrige Undersøgelser, der stadfæster Søvandets Ensartethed med Hensyn til dets øvrige Bestanddele. Søvandets opløsende Evne ligeoverfor den kulsure Kalk skyldes altsaa ikke dets Gehalt paa fri Kulsyre.

Den ovenomtalte Lagdannelse i Biloculinleret kan ogsaa tænkes fremkommet ved en Slemningsproces, hvis Vandets Strømninger paa Bunden er stærke nok til at sætte Slammets fine Partikler i Bevægelse. Dette Spørgsmaal er imidlertid lige saa ubesvaret som de foregaaende. Det fortjener imidlertid at nævnes, at alle de fra Bunden optagne Vandprøver altid var ganske klare og uden Spor af svævende Partikler.

Betragter vi paa Kartet den østlige Grændselinie for Biloculinleret, vil vi finde, at den i Almindelighed gaar imellem 900 og 1100 Favne. Imidlertid træffer vi dog paa flere Steder Biloculinleret paa mindre Dyb, ligesom det ogsaa hænder, at det først begynder at vise sig under 1100 Favne. Mellem 64° og 68° N. B. gaar Biloculinlerets vestlige Grændse op til et grundere Dyb end længere Nord. Paa Stationerne 54, 96 og 248 møder vi det saaledes allerede paa 600, 805 og 778 Favne. Udenom den sidstnævnte Station, der ligger omtrent 50 Mile fra Land, gjør Dybdekurverne for 800—1000 Favne en skarp Bøining (sml. Side 40) indover mod Kysten indtil en Afstand fra denne af ca. 30 Mile; paa denne Strækning ligger Grændsen for Biloculinleret imellem 700 og 800 Favne. Paa den brat skraanende Havbund udenfor Lofoten og Vesteraalen finder vi

an intimate acquaintance with divers conditions as yet wholly unknown. Thus, for instance, we have everything to learn respecting the causes that determine the quantitative and temporary distribution of *Globigerinæ* over the sea-bed. Nor can we from the proportion of non-pelagic foraminiferous shells infer how numerously the living animals were represented in the deposit or the length of the period during which their shells are preserved from decomposition at the bottom of the sea — questions which cannot but exert considerable influence when investigating the mechanical conditions that determine the character and extent of the deposit. One thing is however tolerably certain, that a long time must elapse ere the sea-water can dissolve those calcareous shells. As shown by experiment, they differ from pure carbonate of lime in yielding much more slowly to the action of solvents, by reason of their large proportion of organic substances. Some are disposed to maintain that carbonate of lime is more readily soluble in the depths of the ocean owing to the greater amount of carbonic acid which the water has been held to contain there. Mr. Tornoe, however, in his Memoir on the carbonic acid in the Seas explored by the Norwegian Expedition, has, I think, successfully refuted that assumption. Sea-water he invariably found to react as an alkali; and hence its carbonic acid cannot occur free, but must obviously be combined with oxygen; as regards the proportion of that constituent, it is about the same in the depths as at the surface, and the general uniformity in composition shown by numerous investigations to characterize sea-water, precludes the probability of any deviation in this respect occurring throughout the intermediate strata. The power possessed by sea-water of dissolving carbonate of lime cannot therefore lie in a greater or less proportion of free carbonic acid.

The exceptional formation mentioned above as distinguishing Biloculina clay in some localities, might also be ascribed to the action of bottom-currents, if sufficient to intermingle and keep in motion the fine particles of the deposit. But this, like the foregoing, is a question which for the present we cannot pretend to decide. Meanwhile, all samples of water brought up from the bottom were perfectly clear, without a trace of floating particles.

On referring to the map annexed to this Memoir, the eastern limit of Biloculina clay will be seen to lie at a depth ranging from 900 to 1100 fathoms. In several localities however Biloculina clay is met with nearer the surface, and on the other hand, in some places it does not begin to occur till the depth has reached 1100 fathoms. Between lat. 64° and 68° N., the western limit of the Biloculina clay extends over a shallower part of the seabed than farther north. Thus, for instance, at Stations 54, 96, and 248 it lies at a depth of 600, 805, and 778 fathoms. Without the last of these Stations (about 50 geographical miles from land), the curves of depth for 800 to 1000 fathoms (see page 40) make a sudden bend in the direction of the coast, which they approach within a distance of 30 geographical miles, and throughout this tract the

det imellem 900 og 1100 Favne. I den Bugt af Havbunden, der ligger Nord for Vesteraalen, optræder Biloculinleret først paa et Dyb af mere end 1200 Favne. Grændselinien herfra og nordover indtil den 80de Breddegrad ligger imellem 1000 og 1100 Favne. Paa det samme Dyb begynder Biloculinleret i den sydligere Del af Nordhavet, hvor dette grunder op mod Færo—Islandsbanken.

Jeg har tænkt mig, at den ovenstaaende Betragtning af Biloculinlerets Udbredelse maaske senere kan blive en Støtte ved det fremadskridende Studium af Expeditionens fysiske og zoologiske Materiale. Tildels med det samme Hensyn for Øiet, har jeg anlagt mine kemiske Undersøgelser af dette Sediment, til hvilke jeg nu vil gaa over.

Den kvalitative Undersøgelse af Biloculinleret viser, at det foruden Jern, Lerjord, Kalk, Magnesia, Kiselsyre og Spor af Fosforsyre indeholder smaa Mængder af Manganoxyder. De sidste forekommer dog ikke som synlige Bestanddele af Lermassen i Lighed med de smaa Korn eller Klumper, der saa ofte blev fundne ved Challenger-expeditionen, men synes at maatte være meget fint fordelte i Bundprøverne og udgjør i det Hele taget en saa ringe Del af deres Bestanddele, at de vanskeliggjør en kvantitativ Bestemmelse. Det er muligt, at Manganoxyderne kan bidrage til at give Leret en stærkere brun Farve. Ved Ophedning udvikler Biloculinleret en temmelig stærk empyreumatisk Lugt.

For den kemiske Undersøgelse af Biloculinleret har jeg først og fremst udvalgt mig en Del Hovedstationer fra forskjellige Punkter af Nordhavet og analyseret Bundprøverne fra disse fuldstændig med Hensyn til alle Bestanddele.

I det følgende har jeg opstillet mine Analyser efter Numeret af de Stationer, hvor Bundprøverne er optagne. Bestemmelserne er udført efter den paa Side 36 beskrevne Methode.

Station 51.

N. B. 65° 53'. V. L. 7° 18'. 1163 Favne (2127 Meter). — 1.1°. Lysbrunt Biloculinler.

	Glødningstab	2.71
Dekomponeret af Saltsyre 73.49 pCt.	Jernoxydul	1.14
	Jernoxyd	2.74
	Lerjord	6.49
	Magnesia	0.93
	Kulsur Kalk	52.82
	Fosforsyre	Spor
	Kiselsyre	9.37

boundary for Biloculina clay follows a depth ranging from 700 to 800 fathoms. Over the rapidly shelving bottom off Lofoten and Vesteraalen, it extends between 900 and 1100 fathoms. In the bight of the sea-bed north of Vesteraalen the first Biloculina clay occurs at a depth of more than 1200 fathoms. The boundary-line extending from this locality northwards to the 80th parallel of latitude lies at a depth ranging from 1000 to 1100 fathoms. This is the depth at which Biloculina clay first occurs in the southern part of the North Atlantic, where its bed shoals up towards the Færoe-Iceland bank.

The above elucidative remarks on the distribution of Biloculina clay, will, it is hoped, in some measure serve to facilitate the progressive working out of the large amount of physical and zoological material collected on the Norwegian Expedition. Moreover, my chemical investigation of that deposit, to the results of which I shall now pass on, has been modified with the same object in view.

A qualitative analysis shows that Biloculina clay, along with iron, alumina, lime, magnesia, silica, and traces of phosphoric acid, also contains small quantities of oxide of manganese. The last of these constituents does not however occur in a visible form, as small granules or concretions, so frequently met with on the "Challenger" Expedition, but would appear to be most sparingly distributed throughout the deposit, of which it constitutes so small a proportion as hardly to admit of being quantitatively determined. Possibly, this oxide of manganese gives a darker colour to the deposit. On exposure to heat, Biloculina clay emits a pungent empyreumatic odour.

For my chemical examination of Biloculina clay I selected samples brought up at some of the principal observing-stations in different parts of the North Atlantic, submitting portions of the deposit to a rigorous general analysis embracing all its constituents.

The analyses are arranged according to the numbers of the Stations at which the samples of deposit were collected. The method of determination was that described on page 36.

Station 51.

Lat. 65° 53' N., long. 7° 18' W.; 1163 fathoms (2127 metres); bottom-temperature — 1.1°. Light-brown Biloculina clay.

	Loss by ignition	2.71
Decomposed by Hydrochloric acid 73.49 per cent.	Protoxide of iron	1.14
	Sesquioxide of iron	2.74
	Alumina	6.49
	Magnesia	0.93
	Carbonate of lime	52.82
	Phosphoric acid	Traces
	Silica	9.37

Udekomponeret af Saltsyre 23.29 pCt.	Jernoxyd	1.59
	Lerjord	4.52
	Kalk	1.03
	Magnesia	0.50
	Kiselsyre	15.65
	Sum	99.49

Samlede Bestanddele:

FeO	Fe_2O_3	Al_2O_3	CaO	MgO	$CaCO_3$	P_2O_5	SiO_2
1.14	4.33	11.01	1.03	1.43	52.82	Spor	25.02

Glødn.tab	Sum
2.71	99.49

Station 52.

N. B. 65° 47′. V. L. 3° 7′. 1861 Favne (3403 Meter). — 1.3°. Lysbrunt Biloculinler. En Mængde Foraminiferer, væsentlig Globigeriner.

Biloculinerne i denne Bundprøve var meget store, indtil 2.2 mm i Diameter.

	Glødningstab	4.62
Dekomponeret af Saltsyre 61.35 pCt.	Jernoxydul	0.88
	Jernoxyd	3.65
	Lerjord	3.38
	Kalk	2.52
	Magnesia	0.80
	Kulsur Kalk	45.80
	Fosforsyre	Spor
	Kiselsyre	4.32
Udekomponeret af Saltsyre 33.91 pCt.	Jernoxyd	1.52
	Lerjord	6.62
	Magnesia	Spor
	Kiselsyre	25.77
	Sum	99.88

Samlede Bestanddele:

FeO	Fe_2O_3	Al_2O_3	CaO	MgO	$CaCO_3$	P_2O_5	SiO_2
0.88	5.17	10.00	2.52	0.80	45.80	Spor	30.09

Glødn.tab	Sum
4.62	99.88

Station 178.

N. B. 69° 29′, Ø. L. 12° 26′. 1578 Favne (2886 Meter). — 1.3°. Lysbrunt Biloculinler.

Undecomposed by Hydrochloric acid 23.29 per cent.	Sesquioxide of iron	1.59
	Alumina	4.52
	Lime	1.03
	Magnesia	0.50
	Silicic acid	15.65
		99.49

Constituents of Sample: —

FeO	Fe_2O_3	Al_2O_3	CaO	MgO	$CaCO_3$	P_2O_5	SiO_2
1.14	4.33	11.01	1.03	1.43	58.82	Traces	25.02

Loss by Ignition 2.71 = 99.49.

Station 52.

Lat. 65° 47′ N., long. 3° 7′ W.; 1861 fathoms (3403 metres); bottom-temperature — 1.3°. Light-brown Biloculina clay containing a great many Foraminifera, chiefly *Globigerinæ*.

The *Biloculinæ* in this sample were very large, some measuring 2.2 mm in diameter.

	Loss by ignition	4.62
Decomposed by Hydrochloric acid 61.35 per cent.	Protoxide of iron	0.88
	Sesquioxide of iron	3.65
	Alumina	3.38
	Lime	2.52
	Magnesia	0.80
	Carbonate of lime	45.80
	Phosphoric acid	Traces
	Silicic acid	4.32
Undecomposed by Hydrochloric acid 33.91 per cent.	Sesquioxide of iron	1.52
	Alumina	6.62
	Magnesia	Traces
	Silicic acid	25.77
		99.88

Constituents of Sample: —

FeO	Fe_2O_3	Al_2O_3	CaO	MgO	$CaCO_3$	P_2O_5	SiO_2
0.88	5.17	10.00	2.52	0.80	45.80	Traces	30.09

Loss by Ignition 4.62 = 99.88.

Station 178.

Lat. 69° 29′ N., long. 12° 26′ E.; 1578 fathoms (2886 metres); bottom-temperature — 1.3°. Light-brown Biloculina clay.

	Glodningstab	4.95
Dekomponeret af Saltsyre 53.35 pCt.	Jernoxydul	1.59
	Jernoxyd	2.85
	Lerjord	5.84
	Kalk	0.21
	Magnesia	2.40
	Kulsur Kalk	32.35
	Fosforsyre	Spor
	Kiselsyre	8.01
Udekomponeret af Saltsyre		41.70
	Sum	100.00

	Loss by ignition	4.95
Decomposed by Hydrochloric acid 53.35 per cent.	Protoxide of iron	1.59
	Sesquioxide of iron	2.85
	Alumina	5.84
	Lime	0.81
	Magnesia	2.40
	Carbonate of lime	32.35
	Phosphoric acid	Traces
	Silica	8.01
Undecomposed by Hydrochloric acid		41.70
		100.00

Station 205.

N. B. 70° 51′, O. L. 13° 3′. 1287 Favne (2354 Meter). — 1.2°. Lysbrunt Biloculinler. Gjennemsnitlig omtrent 2 Biloculiner paa hver Kvadratcentimeter af den tørrede Bundprøve. Talrige Globigeriner. Mange af Slægten *Lituola* og enkelte af *Nonionina*. Ingen Stene i Bundprøven.

	Glodningstab	6.06
Dekomponeret af Saltsyre 48.17 pCt.	Jernoxydul	1.44
	Jernoxyd	4.97
	Lerjord	4.08
	Kalk	3.84
	Magnesia	2.82
	Kulsur Kalk	21.00
	Fosforsyre	Spor
	Kiselsyre	10.02
Udekomponeret af Saltsyre		45.77
	Sum	100.00

Station 205.

Lat. 70° 51′ N., long. 13° 3′ E.; 1287 fathoms (2354 metres); bottom-temperature — 1.2°. Light-brown Biloculina clay containing: — *Biloculinæ*, on an average 2 in every square centimetre of the dried sample; numerous *Globigerinæ*, a good many of the genus *Lituola* and a few of the genus *Nonionina*; no pebbles.

	Loss by ignition	6.06
Decomposed by Hydrochloric acid 48.17 per cent.	Protoxide of iron	1.44
	Sesquioxide of iron	4.97
	Alumina	4.08
	Lime	3.84
	Magnesia	2.82
	Carbonate of lime	21.00
	Phosphoric acid	Traces
	Silica	10.02
Undecomposed by Hydrochloric acid		45.77
		100.00

Station 214.

N. B. 70° 39′, Ø. L. 0° 0′. 1665 Favne (3045 Meter). — 1.2°. Mørkbrunt Biloculinler. (Den nederste Del af Bundprøven bestod af graat Ler). En liden Sten, der syntes at være et Stykke af en krystallinsk Skifer, veiende omtrent 0.3 Gr.

	Glodningstab	4.91
Dekomponeret af Saltsyre 52.54 pCt.	Jernoxydul	1.61
	Jernoxyd	4.05
	Lerjord	4.32
	Kalk	0.61
	Magnesia	2.29
	Kulsur Kalk	29.93
	Fosforsyre	Spor
	Kiselsyre	9.73
Udekomponeret af Saltsyre 43.09 pCt.	Jernoxyd	2.28
	Lerjord	8.53
	Magnesia	0.94
	Kiselsyre	31.34
	Sum	100.54

Station 214.

Lat. 70° 39′ N., long. 0° 0′ E.; 1665 fathoms (3045 metres); bottom-temperature — 1.2°. Dark-brown Biloculina clay (lower part of sample grey clay) containing a small mineral fragment, apparently crystalline schist, weighing 0.3gr.

	Loss by ignition	4.91
Decomposed by Hydrochloric acid 52.54 per cent.	Protoxide of iron	1.61
	Sesquioxide of iron	4.05
	Alumina	4.32
	Lime	0.64
	Magnesia	2.29
	Carbonate of lime	29.93
	Phosphoric acid	Traces
	Silica	9.73
Undecomposed by Hydrochloric acid 43.09 per cent.	Oxide of iron	2.28
	Alumina	8.53
	Magnesia	0.94
	Silica	31.34
		100.54

Samlede Bestanddele:

FeO	Fe_2O_3	Al_2O_3	CaO	MgO	$CaCO_3$	P_2O_5	SiO_2
1.61	6.33	12.85	0.61	3.23	29.93	Spor	41.07

Glødn.tab	Sum
4.91	100.54

Station 240.

N. B. 69° 2'. V. L. 11° 26'. 1004 Favne (1836 Meter). — 1.1°. Lysbrunt Biloculinler. En Mængde Foraminiferer, overveiende Globigeriner. To smaa Kvartskorn, veiende 0.1 Gr.

	Glødningstab	5.08
Dekomponeret af Saltsyre 70.47 pCt.	Jernoxydul	0.79
	Jernoxyd	2.71
	Lerjord	3.01
	Kalk	0.98
	Magnesia	0.35
	Kulsur Kalk	54.64
	Fosforsyre	0.22
	Kiselsyre	7.77
Udekomponeret af Saltsyre 23.11 pCt.	Jernoxyd	1.71
	Lerjord	4.75
	Magnesia	0.25
	Kiselsyre	16.40
	Sum	98.66

Samlede Bestanddele:

FeO	Fe_2O_3	Al_2O_3	CaO	MgO	$CaCO_3$	P_2O_5	SiO_2
0.92	7.24	13.52	0.42	1.94	54.64	Spor	24.17.

Glødn.tab	Sum
5.08	98.76

Station 245.

N. B. 68° 21'. V. L. 2° 5'. 2005 Favne (3667 Meter). — 1.4°. To Lag i Bundprøven. Det øverste bestod af brunt, fint Ler med kun ubetydelig Kalkgehalt og ingen Foraminiferer. Det underste Lag var et porøst, lysbrunt Ler med en Mængde Foraminiferer, væsentlig Globigeriner. I det sidste er Analysen foretaget.

Lerets spec. Vægt var 2.72.

	Glødningstab	2.35
Dekomponeret af Saltsyre 53.12 pCt.	Jernoxydul	0.92
	Jernoxyd	3.95
	Lerjord	4.71
	Kalk	0.42
	Magnesia	1.94
	Kulsur Kalk	41.18
	Fosforsyre	Spor
	Kiselsyre	?

Constituents of Sample: —

FeO	Fe_2O_3	Al_2O_3	CaO	MgO	$CaCO_3$	P_2O_5	SiO_2
1.61	6.33	12.85	0.61	3.23	29.93	Traces	41.07

Loss by Ignition
4.91 = 100.54

Station 240.

Lat. 69° 2' N., long. 11° 26' W.; 1004 fathoms (1836 metres); bottom-temperature — 1.1°. Light-brown Biloculina-clay containing great numbers of Foraminifera, principally *Globigerinæ*, and two fine particles of quartz, weight 0.1 gr.

	Loss by ignition	5.08
Decomposed by Hydrochloric acid 70.47 per cent.	Protoxide of iron	0.79
	Sesquioxide of iron	2.71
	Alumina	3.01
	Lime	0.98
	Magnesia	0.35
	Carbonate of lime	54.64
	Phosphoric acid	0.22
	Silica	7.77
Undecomposed by Hydrochloric acid 23.11 per cent.	Sesquioxide of iron	1.71
	Alumina	4.75
	Magnesia	0.25
	Silica	16.40
		98.66

Constituents of Sample: —

FeO	Fe_2O_3	Al_2O_3	CaO	MgO	$CaCO_3$	P_2O_5	SiO_2
0.79	4.42	7.76	0.98	0.60	54.64	0.22	24.17

Loss by Ignition
5.08 = 98.76

Station 245.

Lat. 68° 21' N., long. 2° 5' W.; 2005 fathoms (3667 metres); bottom-temperature — 1.4°. Two layers, — the upper a fine brown clay with but a trifling amount of lime and no Foraminifera; the under a light-brown porous clay containing a great many Foraminifera, chiefly *Globigerinæ*. The analysis is of the bottom part.

Specific Gravity of the Clay 2.72.

	Loss by ignition	2.35
Decomposed by Hydrochloric acid 53.12 per cent.	Protoxide of iron	0.92
	Sesquioxide of iron	3.95
	Alumina	4.71
	Lime	0.42
	Magnesia	1.94
	Carbonate of lime	41. 8
	Phosphoric acid	Traces
	Silica	?

Udekomponeret af Saltsyre 44.43 pCt.	Jernoxyd	3.29
	Lerjord	8.81
	Magnesia	Spor
	Kiselsyre (dek. og udek.)	32.33
	Sum	99.90

Samlede Bestanddele:

FeO	Fe_2O_3	Al_2O_3	CaO	MgO	$CaCO_3$	P_2O_5	SiO_2
0.92	7.24	13.52	0.42	1.94	41.18	Spor	32.33

Glodn.tab	Sum
2.35	99.90

Undecomposed by Hydrochloric acid 44.43 per cent.	Sesquioxide of iron	3.29
	Alumina	8.81
	Magnesia	Traces
	Silica (dec. and und.)	32.33
		99.90

Constituents of Sample: —

FeO	Fe_2O_3	Al_2O_3	CaO	MgO	$CaCO_3$	P_2O_5	SiO_2
0.92	7.24	13.52	0.42	1.94	41.18	Traces	32.33

Loss by Ignition
2.35 = 99.90.

Station 295.

N. B. 71° 59'. O. L. 11° 40'. 1110 Favne (2030 Meter). — 1.3°. Lysbrunt Biloculinler. Ingen Stene. (Som det underste Lag af Bundproven fandtes noget graat Ler). Mange Foraminiferer, men forholdsvis faa Globigeriner, væsentlig *Lituola* og *Nonionina*.

	Glodningstab	5.27
Dekomponeret af Saltsyre 52.79 pCt.	Jernoxydul	1.26
	Jernoxyd	3.57
	Lerjord	9.19
	Kalk	0.92
	Magnesia	0.88
	Kulsur Kalk	27.09
	Fosforsyre	Spor
	Kiselsyre	9.88
Udekomponeret af Saltsyre 42.96 pCt.	Jernoxyd	1.91
	Lerjord	10.33
	Magnesia	0.80
	Kiselsyre	29.92
	Sum	101.02

Samlede Bestanddele:

FeO	Fe_2O_3	Al_2O_3	CaO	MgO	$CaCO_3$	P_2O_5	SiO_2
1.26	5.48	19.52	0.92	1.68	27.09	Spor	39.80

Glodn.tab	Sum
5.27	101.02

Station 295.

Lat. 71° 59' N., long. 11° 40' E.; 1110 fathoms (2030 metres); bottom-temperature — 1.3°. Light-brown Biloculina clay (on a thin under layer of grey clay) containing a great many Foraminifera, but comparatively few *Globigerinæ*, belonging in greater part to the genera *Lituola* and *Nonionina*.

	Loss by ignition	5.27
Decomposed by Hydrochloric acid 52.79 per cent.	Protoxide of iron	1.26
	Sesquioxide of iron	3.57
	Alumina	9.19
	Lime	0.92
	Magnesia	0.88
	Carbonate of lime	27.09
	Phosphoric acid	Traces
	Silica	9.88
Undecomposed by Hydrochloric acid 42.96 per cent.	Sesquioxide of iron	1.91
	Alumina	10.33
	Magnesia	0.80
	Silica	29.92
		101.02

Constituents of Sample: —

FeO	Fe_2O_3	Al_2O_3	CaO	MgO	$CaCO_3$	P_2O_5	SiO_2
1.26	5.48	19.52	0.92	1.68	27.09	Traces	39.80

Loss by Ignition
5.27 = 101.02.

Station 301.

N. B. 74° 1'. V. L. 1° 20'. 1684 Favne (3080 Meter). — 1.6°. Biloculinler, morkere brunt end det foregaaende. (En ubetydelig Mængde graat Underler). Forholdsvis faa Foraminiferer.

Station 301.

Lat. 74° 1' N., long. 1° 20' W.; 1684 fathoms (3080 metres); bottom-temperature — 1.6°. Biloculina clay of a darker brown than the foregoing sample, with a little grey clay in the under part; comparatively few Foraminifera.

	Glødningstab	4.83
Dekomponeret af Saltsyre 22.75 pCt.	Jernoxydul	1.28
	Jernoxyd	5.09
	Lerjord	3.88
	Kalk	0.15
	Magnesia	1.56
	Kulsur Kalk	5.68
	Fosforsyre	Spor
	Kiselsyre	5.11
Udekomponeret af Saltsyre 71.61 pCt.	Jernoxyd	2.64
	Lerjord	15.56
	Magnesia	0.70
	Kiselsyre	52.71
	Sum	99.19

Samlede Bestanddele:

FeO	Fe_2O_3	Al_2O_3	CaO	MgO	$CaCO_3$	P_2O_5	SiO_2
1.28	7.73	19.44	0.15	2.26	5.68	Spor	57.82

Glødn.tab	Sum.
4.83	99.19

Station 302.

N. B. 75° 16′, V. L. 0° 54′. 1985 Favne (3630 Meter). —1.7°. En meget liden Prøve af lysbrunt Biloculinler.

	Glødningstab	3.78
Dekomponeret af Saltsyre 19.95 pCt.	Jernoxydul	1.38
	Jernoxyd	2.94
	Lerjord	3.82
	Kalk	0.81
	Magnesia	2.09
	Kulsur Kalk	8.91
	Fosforsyre	Spor
	Kiselsyre	?
Udekomponeret af Saltsyre 76.27 pCt.	Uopl. Residuum + oplosel. Kiselsyre	76.27
	Sum	100.00

Station 306.

N. B. 75° 0′, Ø. L. 10° 27′. 1334 Favne (2440 Meter). — 1.3°. Biloculinler, mørkere i Farve end det foregaaende. Forholdsvis faa Foraminiferer; foruden Biloculinler fandtes væsentlig *Lituola* og *Nonionina*.

	Loss by ignition	4.83
Decomposed by Hydrochloric acid 22.75 pCt.	Protoxide of iron	1.28
	Sesquioxide of iron	5.09
	Alumina	3.88
	Lime	0.15
	Magnesia	1.56
	Carbonate of lime	5.68
	Phosphoric acid	Traces
	Silica	5.11
Undecomposed by Hydrochloric acid 71.61 pCt.	Sesquioxide of iron	2.64
	Alumina	15.56
	Magnesia	0.70
	Silica	52.71
		99.19

Constituents of Sample: —

FeO	Fe_2O_3	Al_2O_3	CaO	MgO	$CaCO_3$	P_2O_5	SiO_2
1.28	7.73	19.44	0.15	2.26	5.68	Traces	57.82

Loss by Ignition	
4.83	= 99.19

Station 302.

Lat. 75° 16′ N., long. 0° 54′ W.; 1985 fathoms (3630 metres); bottom-temperature — 1.7°. A very small sample of light-brown Biloculina clay.

	Loss by ignition	3.78
Decomposed by Hydrochloric Acid 19.95 per cent.	Protoxide of iron	1.38
	Sesquioxide of iron	2.94
	Alumina	3.82
	Lime	0.81
	Magnesia	2.09
	Carbonate of lime	8.91
	Phosphoric acid	Traces
	Silica	?
Undecomposed by Hydrochloric Acid 76.27 per cent.	Insoluble residue + soluble Silica	76.27
		100.00

Station 306.

Lat. 75° 0′ N., long. 10° 27′ E.; 1334 fathoms (2440 metres); bottom-temperature - 1.3°. Biloculina clay, darker in colour than the preceding sample, containing comparatively few Foraminifera; the genera most numerously represented next to *Biloculina* were *Lituola* and *Nonionina*.

	Glodningstab	2.48
Dekomponeret af Saltsyre 30.40 pCt.	Jernoxydul	1.19
	Jernoxyd	4.92
	Lerjord	2.46
	Kalk	1.08
	Magnesia	1.80
	Kulsur Kalk	12.20
	Fosforsyre	Spor
	Kiselsyre	6.75
Udekomponeret af Saltsyre 68.00 pCt.	Jernoxyd	2.34
	Lerjord	13.44
	Magnesia	1.50
	Kiselsyre	50.72
	Sum	100.88

Samlede Bestanddele:

FeO	Fe_2O_3	Al_2O_3	CaO	MgO	$CaCO_2$	P_2O_5	SiO_2
1.19	7.26	15.90	1.08	3.30	12.20	Spor	57.47

Glodn.tab	Sum
2.48	100.88

Station 351.

N. B. 77° 49', V. L. 0° 9'. 1640 Favne (2999 Meter). — 1.5°. Morkbrunt Biloculinler. Mange Foraminiferer, overveiende Globigeriner. Kun faa af Slægten *Lituola*.

Lerets specifiske Vægt var 2.77.

	Glodningstab	4.56
Dekomponeret af Saltsyre 41.72 pCt.	Jernoxydul	1.25
	Jernoxyd	4.06
	Lerjord	3.28
	Kalk	0.12
	Magnesia	2.05
	Kulsur Kalk	23.66
	Fosforsyre	Spor
	Kiselsyre	7.30
Udekomponeret af Saltsyre 54.20 pCt.	Jernoxyd	2.46
	Lerjord	13.33
	Magnesia	Spor
	Kiselsyre	38.41
	Sum	100.48

Samlede Bestanddele:

FeO	Fe_2O_3	Al_2O_3	CaO	MgO	$CaCO_3$	P_2O_5	SiO_2
1.25	6.52	16.61	0.12	2.02	23.66	Spor	45.71

Glodn.tab	Sum
4.56	100.48

Væsentlig som en Følge af Biloculinlerets vexlende Kalkgehalt viser det sig ved de foregaaende Analyser, at

	Loss by ignition	2.48
Decomposed by Hydrochloric acid 30.40 per cent.	Protoxide of iron	1.19
	Sesquioxide of iron	4.92
	Alumina	2.46
	Lime	1.08
	Magnesia	1.80
	Carbonate of lime	12.20
	Phosphoric acid	Traces
	Silica	6.75
Undecomposed by Hydrochloric acid 68.00 per cent.	Sesquioxide of iron	2.34
	Alumina	13.44
	Magnesia	1.50
	Silica	50.72
		100.88

Constituents of Sample: —

FeO	Fe_2O_3	Al_2O_3	CaO	MgO	$CaCO_3$	P_2O_5	SiO_2
1.19	7.26	15.90	1.08	3.30	12.20	Traces	57.47

Loss by Ignition.
2.48 = 100.88.

Station 351.

Lat. 77° 49' N., long. 0° 9' W.; 1640 fathoms (2999 metres); bottom-temperature 1.5°. Dark-brown Biloculina clay containing a great many Foraminifera, chiefly *Globigerinæ*; but very few belonging to the genus *Lituola*.

Specific Gravity of Clay 2.77.

	Loss by ignition	4.56
Decomposed by Hydrochloric acid 41.72 per cent.	Protoxide of iron	1.25
	Sesquioxide of iron	4.06
	Alumina	3.28
	Lime	0.12
	Magnesia	2.05
	Carbonate of lime	23.66
	Phosphoric acid	Traces
	Silica	7.30
Undecomposed by Hydrochloric acid 54.20 per cent.	Sesquioxide of iron	2.46
	Alumina	13.33
	Magnesia	Traces
	Silica	38.41
		100.48

Constituents of Sample: —

FeO	Fe_2O_3	Al_2O_3	CaO	MgO	$CaCO_3$	P_2O_5	SiO_2
1.25	6.52	16.61	0.12	2.02	23.66	Traces	45.71

Loss by Ignition.
4.56 = 100.48.

Principally by reason of the variable amount of lime in Biloculina clay, the proportion of deposit decomposed

den af Saltsyre dekomponerbare Del er af en meget forskjellig Størrelse. For uhindret at kunne betragte de egentlige Ler-Bestanddeles Forhold ligeoverfor Saltsyre, undlader jeg foreløbig at tage Hensyn til den kulsure Kalk, og har derfor i den følgende Tabel bragt denne Substans tilligemed Glødningstabet i Fradrag og beregnet de øvrige opløselige Bestanddele som Procenter af et kalkfrit Ler. I den nederste Del af Tabellen har jeg opført de paa samme Maade fundne Værdier for Lerets samlede Bestanddele.

Ved Betragtning af denne Tabel kan det synes paafaldende, at de forskjellige Bundprøver viser en saa stor Uoverensstemmelse med Hensyn til den af Saltsyre dekomponerbare Del, medens de Tal, der udtrykker Lerets samlede Bestanddele, tyder paa en nogenlunde ensartet Sammensætning. Hertil maa imidlertid bemærkes, at Behandlingen med Saltsyre ikke kan give noget synderlig værdifuldt Resultat til Sammenligning af de forskjellige Slam-

in hydrochloric acid is seen to differ very considerably in the foregoing analyses. With a view to investigate with greater freedom the effect of hydrochloric acid on the constituents of the true clay, no regard has now been had to the carbonate of lime, and therefore that substance, together with the loss by ignition, has accordingly in the following Table been subtracted from the remaining decomposable parts, which are computed as percentages of a clay exhibiting no trace of lime. The lower columns of the Table show the values, found in like manner, for the united constituents of the deposit.

On examining this Table, it may seem strange that the various samples should exhibit very considerable disagreement as regards the proportion decomposable in hydrochloric acid, while the figures denoting the united constituents indicate a comparatively homogeneous composition. To this objection must however be replied, that the treatment with hydrochloric acid cannot give a particularly valuable result for estimating the chemical composition

	51	52	178	205	214	240	245	295	301	302	306	351	
FeO	2.6	1.9	2.2	2.1	2.6	2.0	1.6	1.9	1.4	1.6	1.3	1.7	Dekomponeret af Saltsyre. Decomposed by Hydrochloric Acid.
Fe_2O_3	6.3	7.7	3.9	7.2	6.3	6.9	7.0	5.3	5.7	3.4	5.9	5.6	
Al_2O_3	15.0	7.2	8.1	5.9	6.7	7.7	8.5	13.8	4.3	4.4	2.9	4.6	
MgO	2.1	1.7	3.3	4.0	3.5	0.9	3.5	1.3	1.8	2.4	2.2	2.9	
SiO_2	21.6	9.1	11.1	14.6	15.1	19.6		14.8	5.7		8.0	10.2	
Sum	47.6	27.6	28.6	33.8	34.1	37.1		37.1	18.9		20.3	25.0	
FeO	2.6	1.9			2.5	2.0	1.6	1.9	1.4		1.4	1.7	Samlede Bestanddele. United constituents.
FeO_2	10.0	11.0			9.8	11.3	12.9	8.2	8.7		8.6	9.1	
Al_2O_3	25.4	21.0			20.0	19.7	24.1	29.3	21.5		18.9	23.2	
MgO	3.3	1.1			3.5	1.5	3.4	2.5	2.5		2.7	2.8	
SiO_2	57.6	63.7			63.7	61.6	57.7	59.1	64.7		68.3	63.8	
Sum	98.9	98.7			99.5	96.1	99.5	101.0	98.8		99.9	100.6	

prøvers kemiske Sammensætning. Saltsyrens opløsende Virkning maa nemlig i høi Grad være afhængig af den Finhed, hvori Slammet befinder sig, og denne er, som forud nævnt, ingenlunde den samme i de forskjellige Partier af Biloculinleret. Denne Uensartethed træder tydelig frem, naar man betragter de forskjellige Prøver under Mikroskopet, og det Resultat man erholder ved Behandlingen med Saltsyre kan nærmest tjene til at belyse det samme Forhold.[1] Det viste sig saaledes, at Bundprøverne fra Stat. 301, 302 og 306, der i Særdeleshed udmærker sig ved lave Tal for de opløselige Bestanddele, ogsaa indeholdt flere grovere Partikler end de øvrige. Som vi strax i det

of the different samples of deposit. The decomposing effect of hydrochloric acid must then depend to a great extent on the relative fineness of the deposit, which, as previously stated, is anything but constant in Biloculina clay. With the aid of the microscope, this want of uniformity is distinctly perceptible, and the result obtained by treating with hydrochloric acid is principally of value in illustrating the same subject.[1] The samples from Stations 301, 302, and 306, distinguished in particular by their small proportion of decomposable constituents, were found to contain a greater number of coarse particles than the others. Moreover, these samples, as will shortly appear, are in an-

[1] Finheden har ikke været afhængig af Pulveriseringen af de tørrede Bundprøver, da jeg altid har sørget for at udføre denne Operation saaledes, at Lerets Partikler derved ikke kunde lide nogen Forandring i sin oprindelige Størrelse.

[1] The fineness of the deposit was not the result of the trituration of the dried samples, since I invariably sought to perform this operation in such manner as to preserve the particles of clay from undergoing any change in magnitude.

følgende skal se, fortjener disse Bundprøver ogsaa af andre Grunde Opmærksomhed, da de hører til det mest kalkfattige Parti af Biloculinleret.

Efter hvad der forud er sagt, vil det være indlysende, at Kjendskabet til Biloculinlerets Kalkgehalt frembyder en særegen Interesse baade for det zoologiske og det fysiske Studium af Havets Naturforhold. Foruden de foregaaende fuldstændige Analyser af Biloculinleret har jeg derfor bestemt dets Kalkgehalt i de fleste af de Prøver, der er optagne indenfor dette Sediments Omraade. I den følgende Tabel findes forøvrigt ogsaa nogle Analyser af Prøver fra Overgangsleret.

other respect deserving of attention, consisting as they do of Biloculina clay from the locality in which that deposit is found to contain the smallest amount of lime.

From what has been previously stated, it must obviously be of special importance for the study of the physical and biological conditions of the sea, to determine the proportion of lime present in Biloculina clay; and I have, therefore, exclusive of that given in the foregoing complete analyses, also determined the amount of lime in most of the samples brought up within the limits of the said deposit. For the rest, a few analyses of transition clay will be also found in the subjoined Table.

Station.	Nordlig Bredde. (N. Lat.)	Længde fra Greenw. (Long. f. Greenw.)	Dybde i engl. Favne. (Depth in Eng. Fath.)	$CaCO_3$	Fe_2O_3	FeO	Samlet Fe (Total Fe.)	Fe_2O_3 : FeO	Anmærkninger. (Remarks.)
37	62° 28′	2° 29′ W	600	9.09	2.08	0.57	1.90	3.65	Overgangsler. — *Transition Clay.*
40	63 22	5 29 W	1215	28.64	2.94	1.79	3.45	1.64	
51	65 53	7 18 W	1163	52.82	2.74	1.14	2.71	2.40	
52	65 47	3 7 W	1861	45.80	3.65	0.88	3.24	4.15	
53	65 13	0 33 E	1539	28.98	3.97	1.08	3.62	3.52	
54	64 47	4 24 E	601	49.18		1.42			
96	66 8	3 0 E	805	24.18	4.15	1.36	3.97	3.05	
98	65 56	5 21 E	388	26.25	3.73	1.33	3.65	2.80	Overgangsler — *Transition Clay*
129	67 40	6 42 E	709	30.14	4.43	0.89	3.79	4.97	(med et under- *or an Under*
178	69 20	12 26 E	1578	32.45	2.85	1.59	3.24	1.80	liggende Lag af *Layer of Grey*
181	69 45	8 43 E	1595	27.63	3.55	1.74	3.83	2.04	graat Ler). *Clay.*
183	69 59	6 15 E	1710	40.52	2.59	1.81	3.22	1.43	
184	70 4	9 50 E	1547	21.77	3.10	1.42	3.27	2.18	
205	70 51	13 3 E	1287	21.00	4.97	1.44	4.60	3.45	
214	70 39	0 0 E	1750	29.93	3.67	1.61	3.82	2.28	
215	70 53	2 0 W	1665	40.88	4.13	1.70	4.28	2.31	Meget tyndt Lag — *An exceedingly*
217	71 0	5 9 W	820	9.23	3.12	1.03	2.98	3.03	af Biloculinler. *thin Layer of*
231	71 21	9 23 W	1032	6.95	3.70	1.76	3.91	2.10	*Biloculina Clay.*
240	69 2	11 26 W	1004	54.64	2.71	0.70	2.51	3.43	
241	68 41	10 54 W	1110	56.25	3.12	1.28	3.18	2.44	
242	68 36	8 40 W	1033	37.95	3.60	1.59	3.76	2.27	
243	68 32	6 26 W	1385	31.25					
244	68 28	4 17 W	1951	36.55	3.71	1.47	3.74	2.52	
245	68 21	2 5 W	2005	41.18	3.95	0.92	3.48	4.30	
245	68 21	2 5 W	2005	4.66	5.85	1.55	5.30	3.77	Øverste Lag af — *Upper Layer con-*
248	67 56	4 11 E	778	33.61					Biloculinleret. *sisting of Biloc-*
249	68 12	6 35 E	1063	55.43	2.09	1.34	3.13	2.23	*ulina Clay.*
285	73 6	11 56 E	1024	1.95	4.49	2.06	4.74	2.18	Overgangsler. — *Transition Clay.*
294	71 35	15 11 E	637	4.02	2.63	0.95	2.58	2.77	
295	71 59	11 40 E	1110	27.09	3.57	1.26	3.48	2.83	
296	72 15	8 9 E	1440	34.88	3.69	1.30	3.59	2.84	
297	72 36	5 12 E	1280	8.70	4.37	1.42	4.16	3.08	
298	72 52	1 51 E	1500	5.52	4.48	1.05	3.95	4.26	
299	73 10	2 14 W	1366	9.70	4.65	1.41	4.35	3.30	
301	74 1	1 20 W	1684	5.68	5.09	1.28	4.56	3.98	
302	75 16	0 54 W	1985	8.91	2.94	1.38	3.13	2.13	
303	75 12	3 2 E	1200	10.84	3.56	1.16	3.32	3.07	
306	75 0	10 27 E	1334	12.20	4.92	1.19	4.37	4.13	
308	74 57	12 43 E	1136	22.32					
332	75 56	11 36 E	1149	25.23	3.63	1.62	3.81	2.24	
344	76 42	11 10 E	1017	3.50	4.00	1.01	4.29	2.09	Overgangsler. — *Transition Clay.*
349	76 30	2 57 E	1487	10.23	4.00	1.15	3.70	3.48	
351	77 49	0 9 W	1640	23.66	4.03	1.31	3.85	3.08	
352	77 50	3 29 E	1686	7.57	4.19	1.52	4.12	2.76	
353	77 58	5 10 E	1333	34.23	2.82	0.90	2.67	3.13	

Jernoxydul og Jernoxyd er bestemt ligesom ved de foregaaende Slamarter.

Det vil fremgaa af Tabellen, at Biloculinlerets Kalkgehalt differerer meget paa de forskjellige Punkter af Havbunden. Ved paa Kartet at opstille Tallene for Kalkmængden vil man imidlertid finde, at en tydelig Lovmæssighed er raadende med Hensyn til Kalkens Fordeling i Biloculinleret, idet visse Partier af dette skarpt adskiller sig fra hinanden i denne Retning.

Vestenfor den Kurve, der paa Kartet er betegnet med 15 % $CaCO_3$, finder vi saaledes et meget kalkfattigt Ler.

Her fandtes i 7 Bundprøver fra 5.7 pCt. til 12.2 pCt. kulsur Kalk og som Middeltal 8.8 pCt. I det store Parti af Biloculinleret søndenfor og østenfor Kurven 15 % $CaCO_3$ finder vi en langt høiere Kalkgehalt. Denne fandtes her ved 22 Bestemmelser at ligge imellem 21 og 40 pCt.; Middeltallet var 30 pCt.

Kurven 45 % $CaCO_3$ betegner den mest kalkrige Del af Biloculinleret. Kalkgehalten i 4 Bundprøver var her fra 45.8 pCt. til 56.2 pCt., Middel 52.4 pCt.

Den mærkelig ringe Kalkgehalt i Biloculinleret vestenfor Kurven 15 % $CaCO_3$ synes at staa i Samklang med de zoologiske Observationer. At dømme efter det forholdsvis ringe Udbytte, der blev indvundet ved Skrabningerne paa denne Del af Havbunden, skulde man tro, at Dyrelivet her stod tilbage i kvantitativ Udvikling. Derimod syntes Slammet her at indeholde mange Stene, der vanskeliggjorde Skrabningerne og paa et Sted (Stat. 350) rimeligvis var Aarsag i, at Trawlen gik tabt.

Denne Afleiring af Stene maa skyldes den drivende Is, hvis Virkninger vistnok i særlig Grad er fremtrædende i dette udprægede polare Parti af Havet. Maaske kan denne Tilførsel af grovere Materiale være Grunden til, at de ovenomtalte Bundprøver fra Stat. 301, 302 og 306 ikke befinder sig i den samme finkornige Tilstand som de øvrige fra den sydligere Del af Biloculinleret.

De Tal, der udtrykker det brune Lers Oxydationsgrad, ligger paa faa Undtagelser nær imellem 3 og 4 (Middel af samtlige Bestemmelser: 3.0). Til yderligere Karakteristik af det eiendommelige kalkfattige Parti af Biloculinleret fortjener det imidlertid at nævnes, at Bundprøverne herfra gjennemsnitlig syntes at være noget høiere oxyderet end de øvrige. I de 8 Bundprøver vestenfor Kurven 15 % $CaCO_3$ fandtes nemlig som Middeltal for Lerets Oxydationsgrad: 3.4; i den øvrige Del af det brune Ler: 2.7.

From this Table, the amount of lime present in Biloculina clay appears to vary considerably in different parts of the ocean-bed. If we set down on the map the figures denoting the proportion of lime, a manifest regularity will, however, be found to characterize the distribution of that constituent in Biloculina clay, with regard to which certain surface-layers of the deposit differ widely from one another.

Thus, for instance, west of the curve 15 % $CaCO_3$ we meet with a clay in which the proportion of lime is exceedingly small.

In 7 samples of the bottom brought up here, I determined from 5.7 per cent to 12.2 per cent of carbonate of lime, the average amount being 8.8 per cent. The extensive surface-layer of Biloculina clay stretching south and east of the curve 15 % $CaCO_3$ was found to contain a much larger proportion of lime. The amount of this constituent, as shown by 22 determinations, ranged from 21 per cent to 40 per cent, averaging 30 per cent.

The curve 45 % $CaCO_3$ indicates the section of the sea-bed within which the greatest quantity of lime has been found in Biloculina clay. The proportion in 4 samples varied between 45.8 per cent and 56.2 per cent, the average amount being 52.4 per cent.

The remarkably low amount of lime, present in Biloculina clay west of the curve 15 % $CaCO_3$, may in part, it would seem, be explained by the results of the zoological observations. To judge from the comparatively meagre yield of dredgings in this part of the ocean-basin, the quantitative development of animal life would not appear to be large. Meanwhile, numbers of large stones — a serious impediment to successful dredging — were, on the other hand, apparently imbedded in the deposit, and the loss of the trawl — at Station 350 — must in all probability be ascribed to their presence there.

This distribution of stones is obviously to a great extent the work of drift-ice in this peculiarly Polar tract of the ocean. Maybe, this addition of coarser material will serve to account for the deposit brought up at Stations 301, 302, and 306 having been much less finely granulated than were the samples of Biloculina clay from more southerly localities.

The figures expressing the oxidation of the brown clay lie, with very few exceptions, between 3 and 4 (the mean for all such determinations was 3.0). As a further characteristic of that deposit west of the curve 15 % $CaCO_3$, where it contains so small an amount of lime, I may mention that, as a rule, the samples would appear to have been more highly oxidized than was the case with those from any other part of the sea-bed. For the 8 samples of brown clay brought up west of the curve 15 % $CaCO_3$, I found the mean degree of oxidation to be 3.4; elsewhere it was 2.7.

Vulkansk Sand og Sandler.

Oen Jan Mayen er som bekjendt af vulkansk Oprindelse. Den stærke lokale Hævning, der har foraarsaget dens Dannelse, giver sig tydeligst tilkjende paa Nordkysten, hvor det egentlige Hovedkrater — den 6000 Fod høie „Beerenberg" — findes. Her træffer vi et Braadyb af 1000 Favne i en Afstand af omtrent 2 Mile fra Øens nordligste Punkt. Paa Øst- og Vestsiden af Øen skraaner Kysten mindre brat ned mod Dybet. Ved de talrige Dybdemaalinger, som Expeditionen her har foretaget, befandtes alle Bundprøver, der var optagne paa mindre Dyb end 600 Favne, at bestaa af et graasort fint Sand eller Sandler, der indeholdt talrige Brudstykker af den basaltiske Lavas Mineraler: Olivin, Augit, Hornblende. Disse forekom ofte med vel uddannede og vel bevarede Krystalflader.

Det vulkanske Sandler viser sig under Mikroskopet at indeholde en Mængde forskjelligfarvede krystallinske Korn, der væsentlig bestaar af de ovennævnte Mineraler, især er den grønne Olivin meget fremtrædende. Forøvrigt ser man ogsaa en Del sorte metalglindsende Korn, der ved Hjælp af Magneten lader sig udtrække af Bundprøverne. Disse synes i det Hele taget at indeholde de samme Mineraler — i fint fordelt Tilstand — som dem der forekommer i de rige Sandleier langs Jan Mayens Kyster. Dette sorte Sand er dannet af temmelig grove Korn af Lava, Tuf, Olivin, Feldspath, Augit, Hornblende og Magnetjern.

Af det sidstnævnte Mineral fandt jeg i Sandet ved to Bestemmelser 26 pCt. og 29 pCt.[1]

Fra disse Sanddynger, der ligger ubeskyttede for Bølgerne langs Øens aabne Kyster, maa der stadig kunne føres nyt Materiale ud til den nærliggende Havbund.

I Syd for Jan Mayen synes der ifølge tidligere Lodskud at være grundt Vand (100 Favne) indtil en Afstand af omtrent 15 Mile fra Øen.

Her har den norske Expedition imidlertid ikke foretaget nogen Dybdemaaling, og jeg tør derfor ikke indestaa for Rigtigheden af de Grændser, jeg paa Kartet har optrukket for det vulkanske Lers Udbredelse søndenfor Jan Mayen.

I Bundprøverne fra Kysten af denne Ø findes næsten ingen Dyrelevninger, og Leret indeholder kun Spor af kulsur Kalk.

[1] Professor Carl Vogt, der i 1863 gjæstede Jan Mayen, har ogsaa underkastet dette Sand en Undersøgelse, ved hvilken han fandt 21.6 pCt. Magnetjern. (Nord-Fahrt entlang der Norwegischen Küste, nach dem Nordcap, den Inseln Jan Mayen und Island, unternommen von Dr. Georg Berna 1863).

Volcanic Sand and Sabulous Clay.

The island of Jan Mayen is, as well known, of volcanic origin. More especially on the north coast, have the prodigous forces whereby the ocean-bed was upheaved in this locality of the North Atlantic, left evidence of their bygone action; there lies Mount Beerenberg, the principal crater — 6000 feet above the level of the sea. About 2 geographical miles from the most northerly extremity of the island we meet with a depth of 1000 fathoms. Off the eastern and western shores, the bottom is found to shelve less rapidly down to the depths. All of the numerous samples collected on the Expedition throughout this tract from depths of less than 600 fathoms, consisted exclusively of a dark-grey sand or sabulous clay, containing fragments of basaltic lava, as olivine, augite, hornblende. Many of these had well developed and well preserved crystal faces.

The volcanic sabulous clay, when examined under the microscope, is found to contain a great many differently coloured crystalline particles, consisting chiefly of the abovementioned minerals, in particular green olivine. For the rest, numerous black granules of metallic lustre are also observed, which, with the aid of a magnet, may be extracted from the clay. They would appear to consist in greater part of the same minerals — in a state of minute subdivision — that occur in the sand forming extensive banks on the coast of Jan Mayen. This black sand is composed of comparatively coarse particles of lava, tuf, olivine, feldspar, augite, hornblende, and magnetite.

The last of these minerals I found, from two determinations, to constitute respectively 26 per cent and 29 per cent of the sand.[1]

These sand-hills, stretching as they do along the exposed shores of the island, must obviously at all times contribute to the distribution of deposit over the adjacent parts of the sea-bed.

South of Jan Mayen — as shown by the results of former soundings — comparatively shallow water (100 fathoms) extends about 15 geographical miles from the coast.

On the Norwegian Expedition, the depth was not measured in this locality, and I cannot therefore answer for the accuracy of the limits I have traced on the map to mark the distribution of the volcanic clay south of the island.

Very few, if any, animal remains are found in samples of the bottom from the coast of Jan Mayen, and the deposit contains traces only of carbonate of lime.

[1] Professor Carl Vogt, who visited Jan Mayen in 1863, has also submitted this sand to analysis: he found 21.6 per cent of magnetite. (Nord-Fahrt entlang der Norwegischen Küste, nach dem Nordkap, den Inseln Jan Mayen und Island, unternommen von Dr. Georg Berna 1863.)

Station 234.

N. B. 71° 6′, V. L. 8° 38′. 259 Favne (474 Meter). — 1.0°. Graasort, tungt, løst sammenhængende Sandler. Flere Stene (veiende indtil 0.3 Gr.), bestaaende af porøs basaltisk Lava og vulkanske Slakker med Olivin. Ingen Dyrelevninger.

	Glødningstab	2.28
Dekomponeret af Saltsyre 26.43 pCt.	Jernoxydul	3.77
	Jernoxyd	3.64
	Lerjord	7.51
	Kalk	3.27
	Magnesia	3.17
	Kulsyre	Spor
	Fosforsyre	Spor
	Kiselsyre	5.07
Udekomponeret af Saltsyre 69.36 pCt.	Jernoxyd	5.59
	Lerjord	15.63
	Magnesia	5.06
	Kiselsyre	43.08
	Sum	98.07[1]

Samlede Bestanddele:

FeO	Fe_2O_3	Al_2O_3	CaO	MgO	CO_2	P_2O_5	SiO_2
3.77	9.23	23.14	3.17	8.23	Spor	Spor	48.13

Glødn.tab 2.28 Sum 98.07

Det vulkanske Sandler har en forholdsvis høi Magnesiagehalt, der vel nærmest maa skrive sig fra den tilstedeværende Olivin.

Station 234.

Lat. 71° 6′ N., long. 8° 38′ W.; d. 259 fathoms (474 m.); b.-t. — 1.0°. A greyish-black, heavy, friable, sabulous clay, containing divers pebbles (the largest weighing 0.3 gr) of porous basaltic lava, and scoriæ with olivine. No animal remains.

	Loss by ignition	2.28
Decomposed by Hydrochloric acid 24.09 per cent.	Protoxide of iron	3.77
	Sesquioxide of iron	3.64
	Alumina	7.51
	Lime	3.27
	Magnesia	3.17
	Carbonic acid	Traces
	Phosphoric acid	Traces
	Silica	5.07
Undecomposed by Hydrochloric acid 69.36 per cent.	Sesquioxide of iron	5.59
	Alumina	15.63
	Magnesia	5.06
	Silica	43.08
		98.07[1]

Constituents of sample: —

FeO	Fe_2O_3	Al_2O_3	CaO	MgO	CO_2	P_2O_5	SiO_2
3.77	9.23	23.14	3.17	8.23	Traces	Traces	48.13

Loss by ignition 2.28 = 98.07.

The volcanic sabulous clay has comparatively a large proportion of magnesia, most of which must in all probability be attributed to the presence of olivine.

Stene paa Havbunden.

De største Stene som fandtes i Bundprøverne havde en Vægt af 10—12 Gram. Størrelsen og Antallet af de i en Prøve forekommende Stene stod, som man paa Forhaand kunde vente, i et direkte Forhold til hinanden. De Bundprøver, hvori de største Stene fandtes, indeholdt i Almindelighed ogsaa de fleste. Ved Betragtning af de Bundprøver, der er optagne efter hinanden i en Rækkefølge fra Land og ud over mod Dybet, har man Anledning til at iagttage, hvorledes Stenene efterhaanden aftager i Størrelse og Antal. I det følgende giver jeg en Fortegnelse over de Bundprøver, i hvilke Stenene maa siges at udgjøre en væsentlig (ikke tilfældig) Bestanddel. Alle disse Bundprøver er optagne

[1] Dette forholdsvis betydelige Tab er muligens fremkommet derved, at jeg har undladt at bestemme Mangan, der i ovenstaaende Prøve syntes at være tilstede i noget større Mængde end i de foregaaende.

Stones on the Sea-Bottom.

The largest pebbles found in the bottom-samples had a weight of from 10 to 12 grammes. The size and number of the pebbles occurring in any such sample, stood, as might naturally be expected, in direct proportion to one another. The bottom-samples in which the largest pebbles occurred, as a rule generally contained the greatest number. On examining the series of bottom-samples taken up from the shore towards the deep water, there is excellent opportunity to observe the gradual decrease of the pebbles in magnitude and number. In the sequel, I have given a List of the samples in which the pebbles must be said to form a principal (not a partial) constituent; and these samples

[1] This comparatively considerable loss probably arises from my having omitted to determine the manganese, which in the above sample would seem to have been present in somewhat greater quantities than in the foregoing.

indenfor det Feldt, der paa Kartet er afgrændset som graat Ler.

Station	32	417	Favne
—	57	161	—
—	100	194	—
—	101	223	—
—	103	193	—
—	114	120	—
—	115	132	—
—	118	141	—
—	120	190	—
—	123	246	—
—	124	350	—
—	134[1]	878	—
—	137	452	—
—	139	175	—
—	142	178	—
—	143	189	—
—	147	142	—
—	164	457	—
—	174	337	—
—	175	415	—
—	195	107	—
—	237	263	—
—	286	447	—
—	290	191	—
—	316	129	—
—	324	233	—
—	334	403	—
—	335	179	—
—	336	70	—
—	340	58	—
—	342	523	—
—	356	110	—
—	358	93	—
—	368	315	—
—	369	87	—
—	370	109	—

Forbinder man med en Linie de yderste og dybeste af de ovennævnte Stationer vil man kunne betragte denne som Grændsen for Stenenes *almindelige* og *regelmæssige* Forekomst i Havbundens Afleiringer. Denne Linie vil nordenfor den 65de Breddegrad omtrent følge Grændsen for det graa Lers Udbredelse.

At dømme efter de Bundprøver, der er optagne søndenfor den 65de Breddegrad, maa man drage den Slutning, at Norges Kystbanker her er meget fattigere paa Stene end længere nord.

I Bundprøverne fra det brune Ler forekommer Stene kun spredt og enkeltvis. Der er imidlertid i denne Henseende en betydelig Forskjel mellem det nordlige og sydlige Parti af Havet. Medens vi i syd for den 72de Breddegrad kun ganske sjelden træffer Stene i Biloculinleret, er

[1] Se Side 40.

were brought up within the tract marked off on the Map as grey clay.

Station	32	417	fathoms
—	57	161	—
—	100	194	—
—	101	223	—
—	103	193	—
—	114	120	—
—	115	132	—
—	118	141	—
—	120	190	—
—	123	246	—
—	124	350	—
—	134[1]	878	—
—	137	452	—
—	139	175	—
—	142	178	—
—	143	189	—
—	147	142	—
—	164	457	—
—	174	337	—
—	175	414	—
—	195	107	—
—	237	263	—
—	286	447	—
	290	191	—
—	316	129	—
—	324	233	—
—	334	403	—
—	335	179	—
—	336	70	—
—	340	58	—
—	342	523	—
—	356	110	—
—	358	93	—
—	368	315	—
—	369	87	—
—	370	109	—

If we connect by means of a line the deepest and outermost of the above-mentioned Stations, such line may be regarded as the limit of the *common* and *regular* occurrence of the pebbles in the surface-layer of the ocean. The said line will, north of the 65th parallel of latitude, very nearly coincide with the distribution of the grey clay.

To judge from the bottom-samples brought up south of the 65th parallel of latitude, we must draw the inference, that the coastal banks of Norway in this locality have their surface-layer far less abundantly supplied with pebbles than is the case with the banks farther north.

In the samples from the brown clay, the pebbles do not occur otherwise than isolated. In this respect, however, there is a considerable difference between the northern and the southern tracts of the ocean. Thus, whereas we, south of the 72nd parallel of latitude, comparatively seldom meet

[1] See p. 40.

disse derimod temmelig almindelige i Dybet vest for Spidsbergen og Beeren Eiland, hvor Drivisen i særlig Grad er fremherskende. Blandt de Stene, som her blev fundne i Bundprøverne, var smaa Stykker af Lerskifer især deleshed talrige. Disse var ofte, medens de endnu befandt sig i fugtig Tilstand, meget bløde, stundom ikke synderlig haardere end almindeligt fast Ler. Hvorvidt nogen Forandring af Stenene i denne Retning kan begunstiges af Forholdene paa Dybet, er et Spørgsmaal, som muligens fortjener nærmere Overveielse.

Hvad der forøvrigt tiltrækker sig Opmærksomhed, er de temmelig hyppige Fund af Flint- og Kridtstykker, der endog forekommer nordenfor den 78de Breddegrad. Som det vil sees, blev der ogsaa paa et Sted (Stat. 100) fundet et i Kridtformationen hjemmehørende Fossil (Belemnites). Kul fandtes i Østhavet (Stat. 266, 269, 275) og i Havet vest for Spidsbergen (Stat. 340, 349, 351). Det kan have sin Oprindelse fra Beeren Eiland og fra Spidsbergen.

De større Stene, der blev optagne med Skraben eller Travlen er nærmere beskrevne i den foregaaende Fortegnelse over Stationerne. Blandt disse kan særlig fremhæves følgende:

Station 18 (en Marmorblok 0.26 × 0.15 × 0.15ᵐ, et Stykke af en Breccie), 32 (Pimpsten etc.), 40 (Se Side 53), 101 (Flint, Kridt etc.), 124 (Flint, Kridt etc.), 137 (Stene med Skurstriber), 147, 164 (Flint, Kridt, Porfyrmandelsten med Skurstriber, lig Holmestrands eller Tønsbergs), 195, 237 (vulkanske Mineraler og Bergarter), 260, 267, 275, (Stenkul), 286, 290, 353 (en Marmorblok ca. 80 Kgr.)

Slutning.

Jeg har paa de første Sider af denne Afhandling kortelig henpeget paa de Kræfter, der paa Forhaand maa antages at have været medvirkende ved Dannelsen af Bundens Afleiringer i Nordhavet.

Idet jeg henviser til disse Slutninger a priori, vil jeg nu forsøge paa i al Korthed at fremstille Resultaterne af de foreliggende Undersøgelser.

Det graa Ler er udbredt over hele Havbunden fra Kysterne og ned til de største Dybder. Fra 900 a 1100 Favne og videre nedover finder vi imidlertid det graa Ler bedækket af et brunfarvet Sediment (Biloculinler), der foruden ved sin Farve udmærker sig ved sit Indhold af visse Foraminiferer, som ikke forekommer paa de høiere liggende Partier af Havbunden, hvor det graa Ler er ubedækket.

with pebbles in Biloculina clay, they are rather common in the deep water west of Spitzbergen and Beeren Eiland, where drift-ice specially abounds. Among the pebbles found here in the bottom-samples, were small fragments of argillaceous schist, exceedingly numerous. Such fragments were often, whilst still in a moist state, very soft, sometimes but very little harder than common, firm clay. Whether any change in the consistence of the pebbles may be produced in the deep layers of the sea, is a question possibly deserving closer investigation.

A phenomenon that also attracts attention, are the numerous fragments of flint and chalk that occur even north of the 78th parallel of latitude. As we have shown, in one locality (St. 100) was found a fossil (belemnite) belonging to the chalk formation. Coal occurred in the Barent's Sea (Stats. 266, 269, 275), and in the ocean-tract west of Spitzbergen (Stats. 340, 349, 351). Its origin may possibly be traced to Beeren Eiland or Spitzbergen.

The larger stones brought up with the dredge or trawl have been more accurately described in the foregoing List of Stations. Amongst such, the following can in particular be specified: —

Station 18 (a block of marble, measuring 0.25 × 0.15 × 0.15, a fragment of a breccia); Stat. 32 (pumice stone etc.); Stat. 40 (see page 33); Stat. 101 (flint, chalk, etc.); Stat. 124 (flint chalk, etc); Stat. 137 (stones with striæ); Stats. 147, 164 (flint, chalk, amygdaloidal porphyry with striæ, bearing a strong resemblance to that occurring at Holmestrand and Tonsberg); Stats. 195, 237 (volcanic minerals and rocks); Stats. 260, 267, 275 (coal); Stats. 286, 290, 353 (a block of marble, weighing about 80 kilogrammes).

Concluding Remarks.

In the first pages of this Memoir, I have briefly pointed out the concurrent forces that may be assumed to have coöperated in forming the deposits covering the bottom of the North Atlantic.

Referring to these *à priori* conclusions, I will now give a brief *resumé* of the results deduced from the investigations here set forth.

The grey clay is distributed over the whole sea-bottom, from the shallowest coastal tracts down to the greatest depths. At a depth of 900 to 1100 fathoms, and still deeper, this grey clay is, however, covered with a brown sediment (Biloculina clay), distinguished, apart from its colour, by containing certain species of Foraminifera that do not occur in the more elevated parts of the sea-bottom, where the grey clay constitutes the surface-layer.

De Bundprøver, der er optagne paa disse mindre Dybder (fra 1100 à 900 Favne og opover), bestaar altsaa udelukkende af graat Ler. Kalkgehalten i disse Bundprøver er temmelig variabel, men opnaar sjelden nogen betydelig Størrelse (Middel af Bestemmelserne ca. 9 pCt kulsur Kalk).

Paa de større Dybder, hvor altsaa det graa Ler kun forekommer som det underliggende Lag bedækket af Biloculinler, indeholder det næsten ingen Dyrelevninger og derfor kun smaa Mængder af Kalk. Biloculinleret synes overalt at ligge som et bestemt adskilt Lag over det graa Ler og gaar ikke gradvis over i dette. Biloculinlerets Kalkgehalt er stærkt varierende, men en tydelig Lovmæssighed giver sig dog her tilkjende, saaledes som det vil fremgaa af det denne Afhandling ledsagende Kart. Da kun et mindre Parti af Biloculinleret indeholder mere end 40 pCt. kulsur Kalk og da alle Observationer stadfæster, at dette Sediment kun danner et tyndt Lag paa Havbunden, kan dette for Nordhavet karakteristiske Dybvandssediment med Hensyn til Kalkrigdom i det store og hele taget ikke sammenlignes med det af de engelske Expeditioner fundne og beskrevne „Globigerina ooze“, der ifølge Prof. Braziers Analyser[1] hovedsagelig bestaar af kulsur Kalk. I Særdeleshed bliver denne Forskjel fremtrædende, naar vi ser hen til det mest kalkfattige Parti af Biloculinleret. Denne Fattigdom paa kulsur Kalk og paa uorganiske Dyrelevninger i det hele taget fører til den ikke uventede Slutning, at Nordhavet med Hensyn til Dyrelivets kvantitative Udvikling staar langt tilbage for de sydligere, varmere Have.

De organiske Kræfter har altsaa i det hele taget kun spillet en underordnet Rolle ved Dannelsen af Nordhavets Afleiringer. Disse synes forøvrigt ogsaa kun at indeholde lidet af saadanne Mineraler, der tilføres Havbunden ved Vulkanernes Udbrud.

De vigtigste Bidrag til disse Sedimenters Dannelse maa vistnok skrive sig fra det Materiale, der gjennem Isen og Bræelvene føres ud i Havet. Hvorledes Nordhavet paa Grund af sine Omgivelser er særlig gunstig stillet for en saadan Tilførsel har jeg paapeget i den første Del af denne Afhandling. Fra Island, Grønland og Spidsbergen, hvor de glaciale Kræfter er saa stærkt fremtrædende, maa der nødvendigvis gjennem de slamrige Bræelve[2] forflyttes store Masser af Landjordens faste Materiale ud i Havet (i det førstnævnte Land understøttes Isens Ødelæggelsesværk ogsaa af den vulkanske Virksomhed). Vi har Grund til at formode, at dette udskyllede Slam vil kunne sprede sig over hele Nordhavets — forholdsvis indskrænkede — Areal forend det fuldstændig bundfældes.[3]

[1] „The Atlantic“ Vol. II Appendix A.

[2] Med Hensyn til de islandske og grønlandske Bræelves Virksomhed henviser jeg til Hr. Stipendiat Amund Hellands Afhandling „Om Islands Jøkler“ og Hr. I. A. D. Jensens „Beretning om en Undersøgelse af Grønlands Vestkyst“, trykt i „Meddelelser om Grønland.“ Kjøbenhavn 1881.

[3] Ifølge en Meddelelse af Prof. Jonstrup skal man kunne opbevare Vandprøver fra de Grønlandske Bræelve i maanedsvis, forend de svævende mineralske Partikler fuldkommen bundfældes.

The samples of the bottom brought up from such lesser depths (from 900 à 1100 fathoms and shallower localities) consist therefore exclusively of grey clay. The amount of lime in these samples varies not a little, but is rarely considerable (mean determination about 9 per cent of carbonate of lime).

In the great depths, where the grey clay occurs accordingly as the under-layer, the surface-layer consisting of Biloculina clay, it contains scarcely any organic remains, and therefore but a small percentage of lime. The Biloculina clay would appear to extend almost everywhere as a well-defined separate layer above the grey clay, and not to pass into it gradually. The percentage of lime occurring in Biloculina clay varies exceedingly, but follows a manifest law, as appears from the chart accompanying this Memoir. A small portion only of the Biloculina clay containing more than 40 per cent of carbonate of lime, and the observations all confirming the fact, that this sediment constitutes but a thin layer, the said deep-water layer occurring on the bottom of the North Ocean cannot, as regards its amount of lime, be compared with that found on the British Expeditions, and termed "Globigerina ooze," which, according to Professor Brazier's analyses,[1] is found to consist chiefly of carbonate of lime. And this distinction is specially obvious if we regard such layers of Biloculina clay as contain the least amount of lime. This small percentage of carbonate of lime and of inorganic animal remains, leads to the warrantable inference, that the North Ocean, with regard to the quantitative development of animal life, cannot compare with the warm southern seas.

Hence, organic agency must, on the whole, be regarded as merely subordinate in the formation of the surface-layers of the North Ocean. Moreover, these layers would appear to contain but a small proportion of the mineral substances spread over the sea-bottom by volcanic eruptions.

The chief portion of these sedimentary formations must apparently consist of the solid matter carried out to sea by drift-ice and glacier rivers. That the North Atlantic, in this respect, by reason of its surroundings, must be favourably situated, has been pointed out in the first part of this Memoir. From Iceland, Greenland, and Spitzbergen, where glacial agency is so prominent, large masses of solid matter detached from the land must, by the glacier torrents,[2] specially rich as they are in ooze, be borne out to sea (in Iceland the destructive action of the ice is augmented by volcanic agency). There is reason to assume, that this ooze must spread over the whole bottom of the North Atlantic — comparatively limited as it is in area — before being thoroughly precipitated.[3]

[1] "The Atlantic." Vol. II Appendix A.

[2] In regard to the Icelandic and Greenland torrents, the reader is referred to Mr. Amund Helland's Memoir "Om Islands Jokler:" and to Mr. I. A. D. Jensen's "Beretning om en Undersogelse af Gronlands Vestkyst," published in "Meddelelser om Gronland," Kjobenhavn 1881.

[3] According to a communication from Professor Jonstrup, samples of water from the Greenland glacier torrents, can be kept for months before the suspended mineral particles are thoroughly precipitated.

De kemiske Undersogelser af Biloculinleret viser, at dets mineralske Blandingsdele er af en forholdsvis ensartet Sammensætning. Nogen væsentlig Forskjel i denne Retning finder man imidlertid hellerikke ved Sammenligning af Biloculinleret med det graa underliggende Ler. Den eneste bestemte Forskjel mellem disse Sedimenter er Oxydationsgraden. Det synes ikke urimeligt at Biloculinlerets stærkere Oxydation (der er Aarsag i dets brune Farve) kan være bevirket af Dyrelivet. En Modsigelse er det imidlertid at Oxydationen tilsyneladende er stærkest i det mest kalkfattige Parti af Biloculinleret.

Jeg haaber senere efter en mikroskopisk Undersøgelse af Bundprovene at kunne belyse disse og de ovrige Sporgsmaal om Slamarternes Dannelse nærmere.

Til Slutning vil jeg udtale min Tak til DHrr. Professorer Brogger, Mohn, Sars og Waage for den Bistand, de velvillig har ydet mig.

Disse Undersogelser er udforte paa Universitetets kemiske Laboratorium paa Hr. Prof. Waages Afdeling fra Mai 1880 til April 1881.

Kristiania, Juli 1881.

From the chemical investigation of Biloculina clay, it appears that the mineral constituents of this substance are comparatively uniform. Meanwhile, there is noc onsiderable difference in this respect between Biloculina clay and the grey underlying clay. The only essential difference distinguishing these sedimentary substances, consists in the degree of oxidation. It is not improbable that the higher degree of oxidation distinguishing Biloculina clay — and to which its brown colour must be ascribed — may arise from animal life. It would seem, however, to be in direct opposition to this view, that oxidation occurs in a higher degree throughout that portion of the Biloculina clay which contains the least amount of lime.

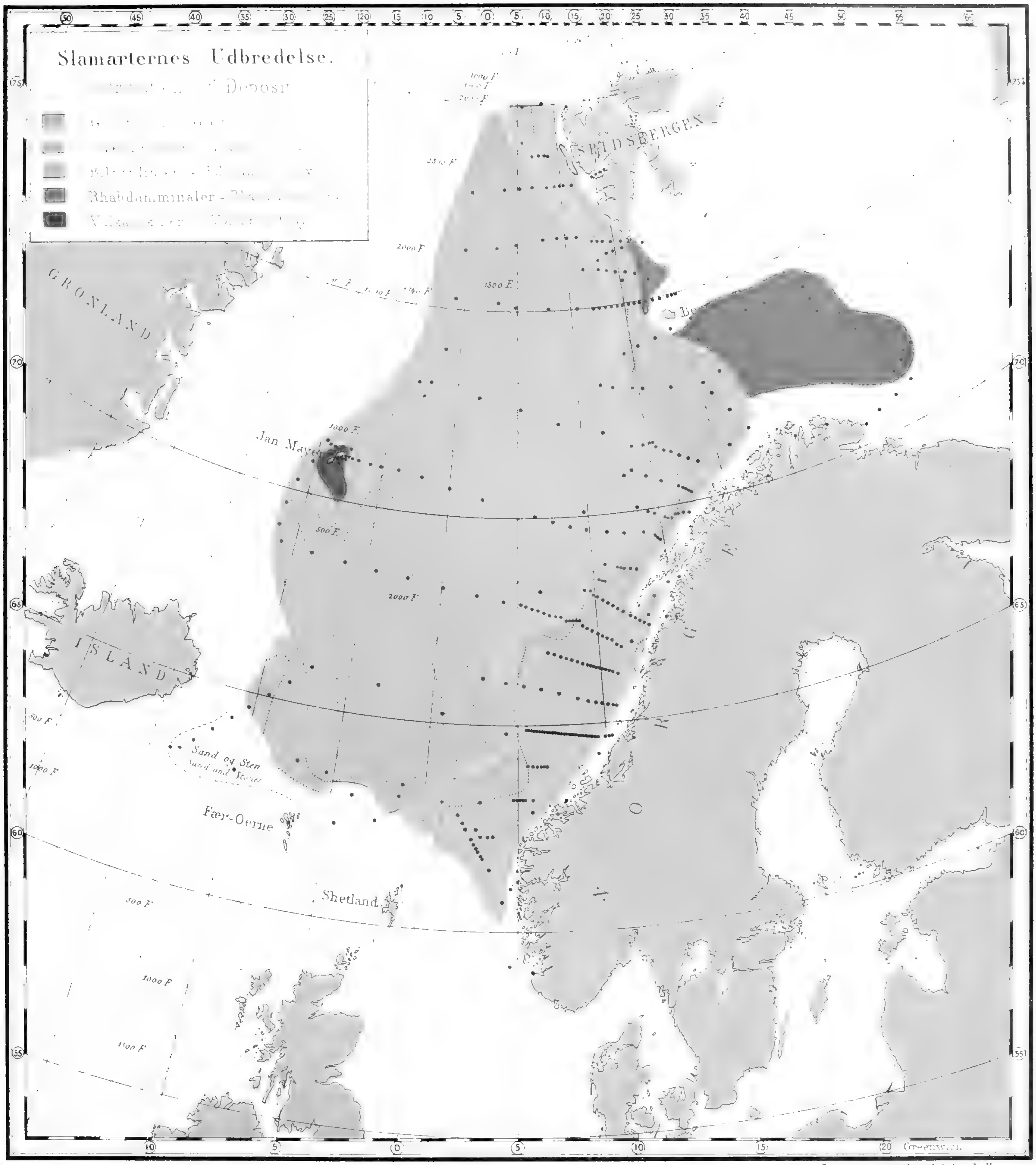
Later, after undertaking a microscopic examination of the bottom-samples, I hope to throw further light on these and the other questions affecting the formation of oceanic deposits.

In conclusion, I will thank Professors Brogger, Mohn, Sars, and Waage for the assistance they have kindly afforded me.

The investigations set forth in this Memoir were made in the Chemical Laboratory of the University, in Professor Waage's department, and extended from May 1880 to April 1881.

Christiania, July 1881.

Translated into English by **John Hazeland.**



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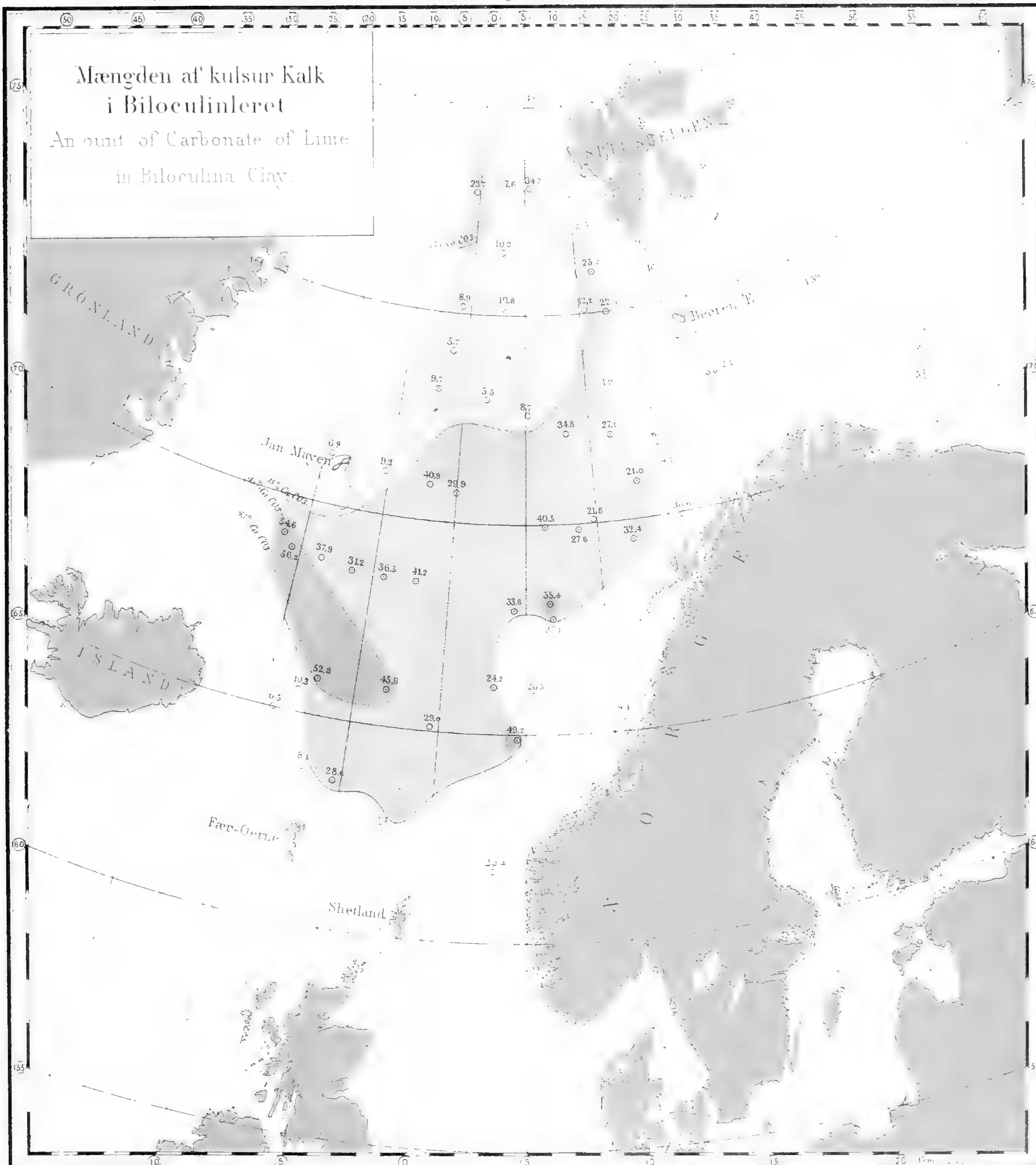

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